TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Fort Nelson Timber Supply Area Analysis Report

March 2000

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Preface

This report contains a timber supply analysis and a socio-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is completed at least once every five years.

To determine allowable timber harvesting levels accurately and rationally, the Chief Forester must have an up-to-date assessment of the timber supply, based on the best available information and reflecting current management direction. **The report that follows provides only this assessment and should not be considered as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code* (FPC) and official land-use decisions made by Cabinet.

Assessing the implications of only current practices rather than looking at a number of different management regimes expedites the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply provide a basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the Chief Forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the Chief Forester with some of the information necessary for these considerations.

The socio-economic analysis considers forestry activity associated with the harvesting and processing of timber harvested from the TSA within the context of regional timber supply and production capacity.

This report is the third of five documents that will be released for each TSA as part of the Timber Supply Review. (The first two documents are the information report and the data package.) This document provides technical information on the results of the timber supply and socio-economic analyses. A separate document called the public discussion paper will summarize the technical information and will provide a focus for public discussions of possible timber harvest levels. The fifth will outline the Chief Forester's harvest level decision and the reasoning behind it.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Fort Nelson Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short (next 20 years) and long (next 250 years) terms. It also examines the potential changes in timber supply resulting from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Fort Nelson TSA covers over 8.2 million hectares in the north-eastern corner of British Columbia. Almost 4.2 million hectares in the TSA are considered to be productive forest, of which about 925 000 hectares are considered available for timber production and harvesting. Within the area available for timber harvesting, most of the forests are dominated by spruce tree species, although there are also significant areas dominated by aspen species. Smaller areas are also dominated by pine, cottonwood, and balsam-fir species. Spruce, aspen, pine and cottonwood are the tree species most commonly harvested by the forest industry in the area.

About 1.5 million hectares within the Cassiar TSA will soon be added to the Fort Nelson TSA. This additional area is remote and highly unlikely to contribute to timber supply for the foreseeable future. However, it will contribute other resource values. The contribution of the additional area and its impact on the Fort Nelson TSA timber supply, if any, will be examined in the next timber supply review.

Current forest management practices follow the standards and legislation set out by the *Forest Practices Code* and therefore the protection of wildlife and the environment will be managed through the Code.

Timber supply was assessed separately for areas of the Fort Nelson TSA with coniferous-leading and deciduous-leading stands. The results suggest that based on current forest practices, a harvest of 1 376 000 cubic metres, can be maintained from coniferous-leading stands over the long term. This timber supply level is 2.3 times greater than the current allowable annual cut for coniferous stands of 600 000 cubic metres. Results also indicate that deciduous-leading stands can support an annual harvest of 900 000 cubic metres, the current deciduous allowable annual harvest, on a sustainable basis. Both the coniferous and deciduous timber supply forecasts are even-flows; that is, projections of constant supply over the 250-year analysis horizon.

The above results reflect current knowledge and information on inventory, management and forest growth. However, uncertainties exist about several factors important in defining timber supply.

In particular, the timber supply analysis examined the implications of two critical uncertainties: the potential contribution of black spruce stands, which were not included in the base case; and the contribution of both coniferous- and deciduous-leading mixedwood stands, which were included in the base case timber harvesting land base.

Black spruce-leading stands were not included in the base case due to uncertainties about the inventory as well as limited harvesting in these stands. Inclusion of all operable black spruce stands above the specified site index thresholds increased the timber harvesting land base by 48% and increased timber supply by 30.5% over the next 100 years compared to the base case harvest projection. A reduction in inventory- and silviculture-related uncertainties — including differentiation between merchantable and unmerchantable black spruce stands, and better understanding of regeneration difficulties associated with high water tables — will be required to provide more clarity on the potential timber supply contribution from these stands.

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Mixed coniferous-deciduous stands comprise 35% of the coniferous timber harvesting land base. Excluding these mixedwood stands decreases timber supply by 27.5% over the next 250 years. Mixed deciduous-coniferous stands comprise almost 32% of the deciduous timber harvesting land base. Excluding deciduous-leading mixedwood stands would decrease timber supply by 19% over the next 100 years, and 33% over the long term. However, the analysis suggests the current deciduous allowable cut could still be achieved for 30 years, while allowing for a gradual decline to the long-term level. Ministry of Forests staff are currently working with the local forest industry to develop a mixedwood management strategy.

An examination of potential alternative harvest forecasts to the even-flow base cases showed that for coniferous stands, only a small increase of 6.3% above the base case level of 1 376 000 cubic metres per year could be achieved for 50 years before a reduction was required. For deciduous stands, the alternative forecast showed the potential for substantial increases (averaging 45%) above the base case over the next 100 years. The abundant deciduous inventory relative to the current deciduous allowable harvest can provide a buffer against uncertainties that affect timber supply.

Sensitivity analysis indicated that uncertainties about inventory, management assumptions and growth and yield could affect timber supply as indicated in the above base cases to varying degrees.

The uncertainty with the largest effect, other than the critical issues discussed above (inclusion of black spruce-leading stands, and exclusion of mixedwood stands), is associated with site index thresholds used to exclude stands of low productivity from the timber harvesting land base. The site index thresholds were developed from a review of recent harvesting operations; nevertheless, they are still uncertain, given potential shifts in costs and market prices. The even-flow coniferous timber supply forecast could vary from 19% less to 32% more than the base case depending on whether the upper or lower end of a range representing uncertainty in site index threshold were used. For deciduous stands, timber supply could increase to 21% above the base case if the lower end of the site index threshold were used. Based on the upper end of the threshold, the current deciduous allowable cut could be maintained, but a declining harvest forecast would be required, and long-term timber supply would be 35% lower.

The interaction between uncertainty about both the contribution of mixedwood stands and the appropriate site index thresholds could also have large effects on timber supply. Analysis demonstrated the significant potential for uncertainty in the site index thresholds either to exacerbate or offset any timber supply reductions associated with exclusion of all or some of the mixedwood stands from the timber harvesting land base.

Uncertainties with moderate effects on coniferous and deciduous timber supply include: volume estimates for existing stands, volume estimates for regenerated stands, and the land base to which landscape-level biodiversity seral-stage requirements apply. For the deciduous land base, cottonwood- and birch-leading stands contribute moderately to timber supply.

At this time, there is no evidence specific to the Fort Nelson TSA to suggest that estimates used in the analysis for existing or regenerated stands are inaccurate. Any new information on growth and yield collected or derived as part of ongoing provincial programs can be used in future analyses.

Current provincial policy on landscape-level biodiversity, which is reflected in the base case, is that objectives should be achieved as much as possible in forest outside of the timber harvesting land base. Assuming that forest outside the timber harvesting land base contributes to landscape-level biodiversity, the analysis suggested that even application of early, mature-plus-old and old seral requirements corresponding to higher biodiversity emphasis in all draft landscape units would not affect the harvest forecasts. This lack of effect is due to the abundance of forest outside the timber harvesting land base in most landscape unit — biogeoclimatic variant combinations. Conversely, if the requirements needed to be achieved on the timber harvesting land base, as well as on the entire forest area, the coniferous timber supply forecast would drop by 8% compared to the base case. Deciduous timber supply in the short- and medium-terms would be unaffected, while long-term timber supply would drop by 10% compared to the base case.

Executive Summary

Cottonwood stands make up 12% of the deciduous timber harvesting land base. These stands are currently considered harvestable, but their merchantability is highly variable. If cottonwood-leading stands were excluded from the timber harvesting land base, the deciduous base case could be maintained for 13 decades, but projected long-term timber supply would decline to 11% below the base case.

Birch-leading stands were not part of the base case timber harvesting land base. The current inventory suggests that the addition of birch stands would increase the deciduous timber harvesting land base by 7.4%, and provide a sustainable supply of 55 000 cubic metres, an increase in the deciduous supply of 6%.

Uncertainties and issues with small to negligible effects on coniferous and deciduous timber supply include: visual quality management, forest cover requirements used to approximate the effects of cutblock adjacency guidelines, exclusion of recently designated parks from the timber harvesting land base, and minimum harvestable ages. Visual quality objectives apply to only 12% of the coniferous and 14% of the deciduous timber harvesting land bases, and forest outside of the timber harvesting land base meets most of the visual objectives.

In 1997, government approved a *Land and Resource Management Plan* (LRMP) for the Fort Nelson area. In June 1999, a total area of 842 271 hectares of protected areas identified in the LRMP were officially designated under the *Park Act*, of which 750 945 hectares are within the Fort Nelson TSA. When the analysis was undertaken, the areas were not designated, and the information available at that time was used for the sensitivity analysis. Exclusion of the these areas, which closely approximate the final designation, reduced the coniferous harvest forecast by 2%, consistent with the contribution of the proposed areas to the timber harvesting land base. The deciduous harvest forecast was not affected over the 250-year analysis horizon, because the abundance of growing stock absorbed the inventory reduction associated with the land base exclusion. However, over the very long term (beyond the 250-year analysis horizon), timber supply would need to decline by 2% to correspond with the slightly smaller land base.

Minimum harvestable ages did not affect supply primarily because the use of an even harvest flow defined the transition between existing and regenerated stands more so than harvestable ages. Forest cover requirements to approximate the effects of cutblock adjacency guidelines did not affect timber supply because of the flexibility to move among different areas of the TSA.

As a final note on coniferous timber supply, in none of the sensitivity analyses was the supply reduced to the current coniferous allowable annual cut (600 000 cubic metres). Downward influences on the base case timber supply would need to combine to 56% to result in a reduction to the current allowable cut.

The Fort Nelson TSA economy is dominated by the forestry sector; however, the oil and gas industry, tourism, and supply and services also contribute to the local economy.

The current Fort Nelson TSA AAC of 1 500 000 cubic metres can support a provincial total of approximately 1,200 person-years of direct employment if fully harvested and processed. Residents of the Fort Nelson TSA account for approximately 70% of this direct employment. The Fort Nelson TSA forestry sector supports a further 1,425 person-years of indirect and induced employment across the province.

If the harvest were to increase to 2 276 000 cubic metres per year, direct employment could increase by approximately 620 person-years across the province and indirect and induced employment could increase by approximately 730 person-years. This scenario is without consideration for the critical issues surrounding the base case harvest forecast.

Provincial government revenues would also increase. Stumpage and related payments, industry taxes, and employee income taxes could increase to $63.9 million per year — an additional $24.6 million per year, assuming a continuation of current tax rates.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth pattern. Decisions about whether a stand is available for harvest often depend on how its harvest could affect other forest values, such as wildlife or recreation.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood.

Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the Chief Forester of British Columbia in determining an allowable annual cut (AAC)*.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units throughout British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 *of the* Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

Sections 1 through 7 of this report describe the timber supply analysis for the Fort Nelson TSA. Following a brief description of the area in Section 1, Section 2 addresses some important timber management issues in the Fort Nelson TSA. Section 3 provides a discussion of data preparation and formulation of assumptions, and Section 4 outlines the timber supply analysis methodology. Timber supply analysis results, including an assessment of the critical timber management issues, are presented in Section 5. Section 6 examines the sensitivity of the results to uncertainties in the data and assumptions used, and is followed by a summary and conclusions.

Appendix A contains further details about the data and assumptions used in this analysis.

As part of the timber supply review, information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis section of this report provides the Chief Forester with some of the information necessary for these considerations. The socio-economic analysis also provides information for the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Fort Nelson TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by undertaking a socio-economic analysis using the harvest forecasts* as projected in the base case.

The socio-economic analysis includes an estimate of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and woodlands related activities, processing, and silviculture. Employment is measured in terms of person-years*. Employment income is calculated using average industry income estimates.

Data on direct employment, harvest levels, and fibre flows were obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. If someone works full-time for 90 days, he or she accounts for 0.5 person-years.

Introduction

Indirect and induced employment were calculated using the Fort Nelson TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for these indirect and induced imports.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates should only be viewed in a general way.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

1 Description of the Fort Nelson Timber Supply Area

The Fort Nelson TSA is situated in the north-eastern corner of the province within the Prince George Forest Region. This TSA, administered from the Fort Nelson Forest District office in Fort Nelson, is the second largest timber supply area in the province, covering more than 8.2 million hectares. It is bordered on the east by Alberta, on the north by the Northwest and Yukon Territories, on the west by the summit of the northern Rocky Mountains and the Bulkley/Cassiar Forest District, and on the south by the Fort St. John and Mackenzie Forest Districts.

The eastern part of the TSA, nearest the Alberta border, is an extension of the Great Plains (or Alberta Plateau). In the southern part of the TSA, these plains grade into the foothills of the northern Rocky Mountains at the western boundary of the TSA. In the northern portion, the plains grade into the Liard River basin and the Liard Plateau.

About one-half of the Fort Nelson TSA is considered productive forest area (about 4.2 million hectares). Currently 22.1% of that productive forest (or 11.3% of the total TSA) is considered available for harvesting. The current AAC of 1 500 000 cubic metres was determined in 1994. This harvest level is partitioned with 600 000 cubic metres per year for coniferous-leading species and 900 000 cubic metres per year for deciduous–leading species.

The main community is the town of Fort Nelson, where three-quarters of the TSA's population live. Other communities include Prophet River, Toad River, and Muncho Lake. The Fort Nelson Forest District encompasses the TSA and includes Muncho Lake Park, Stone Mountain Park, Northern Rocky Mountains Park and part of the Muskwa-Kechika Management Area, as well as several other small parks and protected areas*.

The TSA boundary is being amended and once complete, about 1.5 million hectares, currently part of the Cassiar TSA, will be added to the Fort Nelson TSA. The area added to the Fort Nelson TSA is remote and not expected to contribute significantly to timber supply over the next several years. However, it will contribute to other resource values of the Fort Nelson TSA. The contribution of the additional area and its impact on the Fort Nelson TSA timber supply, if any, will be examined in the next timber supply review.

In June 1999 as part of the *Fort Nelson Land and Resource Planning* process, eleven new parks totalling 842 271 hectares were designated. The Fort Nelson timber supply analysis began prior to their designation, however they are examined in a sensitivity analysis* (see Section 6.11, "Uncertainty regarding establishment of new protected areas"). By April 2000, it is anticipated that an additional eleven new areas will become protected areas or ecological reserves through Orders-in-Council (OIC).

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

Sensitivity analysis
Process that examines how uncertainty in data and management assumptions affect timber supply.

1 Description of the Fort Nelson Timber Supply Area

1.1 The environment

The Fort Nelson TSA contains three biogeoclimatic zones*, with the Boreal White and Black Spruce being the predominant one (covering about two-thirds of the TSA's land base). Table 1 summarizes the zones and their locations, the major tree species present, and other considerations such as climate and wildlife values.

Table 1. Biogeoclimatic zones of the Fort Nelson Timber Supply Area

Zone	Location	Tree species	Other
Boreal White and Black Spruce	Covers most of the eastern portion of the TSA, up to an elevation of 1300 metres. Occupies 74% of the TSA land base.	Dominant: white spruce, lodgepole pine, trembling aspen. Minor: black spruce, balsam poplar, tamarack, subalpine fir, common paper birch and Alaska paper birch.	Long, very cold winters and short growing seasons. Rich in wildlife.
Spruce Willow Birch	On middle elevations of northern Rocky Mountains and much of the Liard Plateau (1300 metres to 1500 metres). Occupies 16% of TSA land base.	Lower elevations Dominant: white spruce and subalpine fir. Minor: black spruce, lodgepole pine and trembling aspen. Upper elevations Dominated by tall deciduous shrubs (birch, willow species).	Harshest climate of all forested zones in B.C. Winters long and cold, summers short and cool. Major wildlife use in summer months.
Alpine Tundra	Above 1500 metres. Occupies 10% of TSA land base.	Trees generally absent. Plants are small, close to ground, and often widely separated by bare soil or rock.	Harshest climate of all B.C. zones. Wildlife diversity and occurrence are low.

The severe climate of the Fort Nelson TSA limits wildlife occurrence in some isolated portions or at certain times of year. However, this TSA also contains vast tracts of relatively undeveloped land that support abundant, diverse and internationally significant wildlife populations. Large mammals such as moose, black and grizzly bear are common, as are smaller furbearers such as wolverine, wolf, lynx, weasel, mink, river otter, beaver and coyote. Regionally significant species include mountain goat, caribou, marten, Stone's sheep, elk, harlequin duck and northern goshawk.

In British Columbia, the Boreal White and Black Spruce Zone has the least snowfall of all the northern zones and consequently is very important for wintering ungulates. Also in this zone, frequent forest fires have formed a mosaic of upland forests of different ages, providing a variety of habitats. The extensive deciduous forests frequently achieve older ages and are important for ungulates, birds and small mammals.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.

Because of the harsh climate, few reptile and amphibian species are present in the TSA. However, the TSA supports a wide range of bird species, many of them eastern species not otherwise found in British Columbia. Conversely, many birds found in other parts of the province do not occur in this TSA. The abundant rivers, lakes, and wetlands provide important staging grounds during the migration of waterbirds such as pintails, widgeons, geese and teal.

Many fish species important as game are found in the waterbodies of this area. These include some trout species, whitefish, burbot, Arctic grayling, northern pike and walleye. The rare occurrence of some salmon species has also been noted in some of the major rivers. Approximately 15 game and non-game fish species occur only in this corner of the province.

Species considered at risk in the Fort Nelson TSA are summarized in Table 2.

Table 2. Vulnerable, endangered and threatened species, Fort Nelson TSA

Endangered or threatened (red-listed)	Vulnerable (blue-listed)	
Bay-breasted warbler	Short-eared owl	northern long-eared myotis
Cape May warbler	American bittern	*luscus* wolverine
black-throated green warbler	trumpeter swan	fisher
Connecticut warbler	sandhill crane	grizzly bear
Nelson's sharp-tailed sparrow	surf scoter	bull trout
wood bison	Philadelphia vireo	
emerald shiner	Canada warbler	
ninespine stickleback		
cisco		
spottail shiner		

B.C. Conservation Data Centre Tracking List, November 1998.

Current forest management practices follow the standards and legislation set out by the *Forest Practices Code**. Consequently the protection of wildlife and the environment will primarily be managed through the Code. Some inventory work and development of management guidelines is currently underway to mitigate impacts to fish and wildlife as anticipated by the Code. The *Fort Nelson Land and Resource Management Plan (LRMP)**, approved by the provincial government in the fall of 1997, also provides direction for forest management practices that protect environmental values. These practices were considered in this timber supply analysis.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

Overall, the *Fort Nelson Land and Resource Management Plan* improves the outlook for most wildlife species and their habitats. However, plant and animal species dependent on mature- and old-growth forests remain at moderate risk levels due to forest harvesting activities which will convert older forests to young forests. These species include furbearers (martens, the blue-listed fishers) and songbirds (various red-listed warblers). Only a small proportion of the total land base is considered available for timber harvesting and the impacts associated with timber harvesting may be mitigated through more detailed, landscape-level planning currently in progress.

The *Land and Resource Management Plan* also addresses the issue of open-roaded access, considered to be a potential risk factor to all ungulate species. However, virtually no open-roaded access presently exists in the TSA as the majority of access is via winter roads developed to service the forest, and oil and gas industries. The plan provides for future coordinated access management strategies to mitigate this potential risk. The impacts of extensive seismic operations on fish and wildlife is unknown at present, but would primarily result from habitat disturbance by these linear features.

1.2 First Nations

The Fort Nelson TSA is covered by Treaty 8. The signatories to the treaty are the Fort Nelson First Nation, the Dene Tsaa Tse K'Nai First Nation (from Prophet River) and the Dena Tha' First Nation (from Assumption, Alberta). In addition, the Kaska-Dena First Nations have traditional territory in the TSA.

Some First Nations members are employed directly or indirectly in the forestry, and oil and gas industries. Higher harvest levels may lead to more economic opportunities for First Nations through involvement in the forest industry. The specific impacts that First Nations communities could experience would depend upon their desired role and their geographic proximity to forest activity.

An archaeological overview assessment and mapping of archaeological potential have been completed for the Fort Nelson TSA. Traditional use studies are ongoing.

For more information on the Fort Nelson TSA communities and First Nations, see Section 8.1.1, "Current population and demographic trends".

1 Description of the Fort Nelson Timber Supply Area

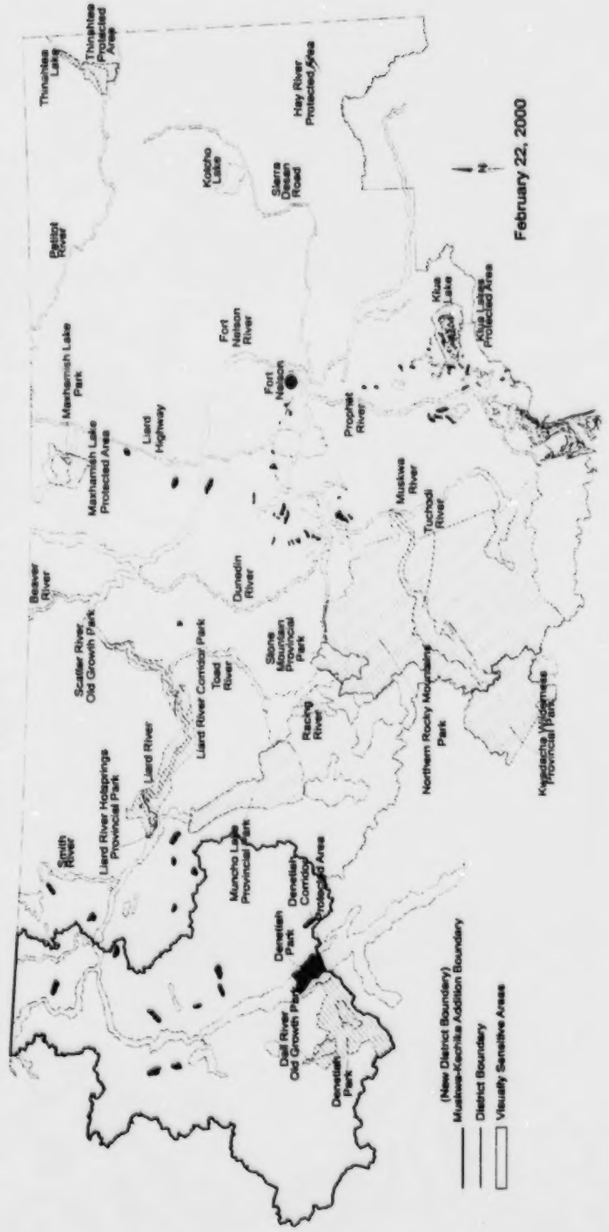


Figure 1. Map of the Fort Nelson timber supply area, including visually sensitive areas.

2 Critical Issues

The Fort Nelson TSA covers over 8.2 million hectares in northeastern B.C. About one-half of this area is currently classified as productive forest land. Forest harvesting activity has occurred over only a small proportion of this large forest area, in only some types of stands and over a relatively short period of time compared to the rest of the province.

Black spruce-leading and coniferous-leading mixedwood stands were not included in the timber harvesting land base* in previous analyses and AAC determinations. While harvesting in both mixedwood and black spruce stands has increased recently, the degree to which these forest types* will contribute to timber supply remains uncertain.

For this timber supply review (TSR), both coniferous- and deciduous–leading mixedwood stands contribute to the current management, or base case, timber harvesting land base. Black spruce stands, however, continue to be excluded from timber harvesting land base. This section discusses timber management and inventory issues, and related uncertainties, that are important in defining the area that can reasonably be considered available for timber harvesting and production in the Fort Nelson TSA. These issues relate to:

- the extent, nature and operability* of black spruce stands;
- silviculture in coniferous- and deciduous–leading mixedwood stands.

2.1 Black spruce stands

The area of the TSA that is covered with black spruce-leading stands and the extent to which these stands contribute to timber supply are both uncertain.

Forest inventories for the Fort Nelson TSA date from 1970 to 1989, depending on the specific area. The inventory has been updated for disturbances, and projected for growth and aging of the forest, and provides a satisfactory overview of the forest in the area. However, significant uncertainty surrounds the specific characteristics of particular areas and stand types. Over the last 30 years, views on which species of trees are merchantable have changed significantly. Black spruce and lodgepole pine were not considered merchantable when some of the older inventories were done. Given the large area of black spruce forest and the relatively small amount of lodgepole pine in the Fort Nelson area, spruce is the focus from a timber supply perspective.

Older inventories contain a lower level of resolution for stand types that historically have been less economically attractive. For example, some areas of predominantly non-productive brush surrounding small pockets of black spruce have been classified as black spruce stands, or conversely as entirely non-productive brush.

In addition, given the lack of economic interest in these stand types, there is lower confidence in the accuracy of forest cover attributes in the inventory. The overall result is uncertainty about the composition and extent of black spruce forest in some parts of the TSA. It is not known whether the overall area of black spruce forest is under- or over-estimated.

In preparing the data package for the Fort Nelson TSA, forest district staff reviewed recent harvesting records, and developed criteria for defining the timber harvesting land base. The records indicated some harvesting has occurred in black spruce stands in the TSA, and according to the land base definition criteria, a significant area of black spruce stands would have been classified as contributing to timber supply (see Table 3 below). However, subsequent review has shown that black spruce-leading stands, even if they meet or exceed the merchantability criteria for white spruce, are seldom harvested unless they are adjacent to stands of other species where harvest is occurring. Isolated or large contiguous black spruce stands are rarely harvested. Due to lack of inventory resolution, in some instances an overlay of cutblock* boundaries onto an inventory map may suggest a harvested stand was predominantly black spruce, while the actual stand may have had different characteristics (e.g., tree heights, productivity or species composition).

Timber harvesting land base
Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Forest type
The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Cutblock
A specific area, with defined boundaries, authorized for harvest.

Black spruce stands are not specifically targeted for harvesting primarily because of small piece size, and silvicultural and regeneration difficulties associated with a high water table. As more specific ecological (site series) inventories are completed, it may be possible to make specific land base exclusions where regeneration problems are anticipated because of a high water table often associated with black spruce stands. At this time site series information is not available, and no reductions could be made in this analysis to account for such issues.

Given inventory and management uncertainties and very limited harvesting performance in black spruce-leading stands, Forest Service staff believe it would be inappropriate to include these stands in the timber harvesting land base for this analysis. It is recognized that black spruce forms a significant portion of the forest inventory in the Fort Nelson TSA and that improved inventory and management information will likely lead to inclusion of some black spruce stands in the timber harvesting land base in the future. It is not possible to speculate on the potential degree of inclusion at this time. However, the potential contribution of black spruce stands will be examined as a critical issue in Section 5, "Results."

2.2 Coniferous– and deciduous–leading mixedwood stands

The history of harvesting and silviculture activities in mixedwood stands in the Fort Nelson TSA is limited. Development of both coniferous and deciduous (primarily aspen) timber processing facilities in Fort Nelson has recently led to increased interest in mixedwood stands. In response to this local interest, the Ministry of Forests and the local licensee have jointly developed an interim mixedwood management strategy. While the interim stocking* guidelines for boreal mixedwood (Kyle 1997) have been released, there is still uncertainty about the dynamics of mixedwood stands under both natural and managed conditions (Williams and others 1999).

Silvicultural techniques for mixedwood stands, including protection of advanced understorey regeneration, are currently under development. However, because of limited experience in the area, appropriate practices remain somewhat uncertain.

Mixedwood stands are characterized by changes in species composition over time. Such changes are not recognized in the older inventories that cover part of the Fort Nelson TSA.

Like black spruce stands, the mixedwood resource is clearly large in the Fort Nelson TSA. However, the degree to which these stands will contribute to timber supply is uncertain at this time, due to significant inventory and management uncertainties. Given the increasing interest in, and ongoing work regarding mixedwood stands, they will be included in the timber harvesting land base. Due to the uncertainties associated with the operations currently taking place in these stands, the timber supply contribution of mixedwood stands will be examined as a critical issue in Section 5, "Results".

Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

3 Information Preparation for the Timber Supply Analysis

The following sections provide an outline of the information used in the timber supply analysis. This information can be divided into three general categories: land base inventory; timber growth and yield; and management practices.

3.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled by the B.C. Forest Service, Resources Inventory Branch in 1997. This file contains information on the forest land in the Fort Nelson TSA including the geographic location, area, nature of the forest cover (such as presence or absence of trees; species, number and age of trees; and timber volume), environmental sensitivity, and occurrence of range burns or seismic activities. Stand characteristics such as tree height, stocking and age have been projected to 1997. Also, the file has been updated to account for timber harvesting up to January 1, 1996.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and on areas where timber harvesting is not expected to occur. Examples are lands set aside for parks, areas needed to protect wildlife habitat, power line right-of-ways, highways, or town sites. A general description of these areas specific to the Fort Nelson TSA is provided below.

Before assessing timber supply, the TSA is classified and specific areas (e.g., stand of trees) are assigned either to the timber harvesting land base, or to the non-contributing land base. There is no double counting of area; for example, the area of a forest stand that falls within a park, and also has sensitive soils, is assigned only once to the non-contributing land base.

Identifying areas not contributing to timber supply does not mean the area is also removed from the Fort Nelson TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described herein is consistent with this philosophy.

3 Information Preparation for the Timber Supply Analysis

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

For the Fort Nelson TSA, the following types of areas do not contribute to the timber harvesting land base.

- non-Crown area — areas not managed directly by the B.C. Forest Service (e.g., private land, parks).
- non-productive areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-typed areas — areas for which inventory type information is unavailable (usually non-forest).
- naturally disturbed areas — areas which are not satisfactorily restocked (NSR)* after a natural disturbance such as wild fire.
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.
- non-merchantable — areas covered by timber stands that are not currently used by local processing facilities.
- low timber productivity areas — areas occupied by forest with low timber-growing potential.
- alpine — high elevation areas identified as alpine tundra (AT) and subalpine parkland in the biogeoclimatic classification that were not deducted in other categories noted above, such as non-productive areas.
- riparian reserves — area otherwise available for timber production that is assumed to be unavailable for harvesting to provide protection for riparian ecosystems.
- environmentally sensitive areas* — areas considered to have wildlife or recreational significance, areas with highly sensitive soils, and areas where problems with regeneration are anticipated.
- wildlife range areas — areas managed to promote wildlife grazing through use of prescribed fire.
- unclassified existing roads, trails and landings — areas of forest land that have been removed from timber production due to access development and harvesting to date, but are too small to be classified as non-forest area.
- stand-level biodiversity* — patches of standing timber larger than two hectares maintained within harvested areas to provide for the maintenance of stand structure over time.
- seismic activity — areas of forest land that have been removed from timber production due to extensive oil and gas exploration and development to date. Future forest depletion due to seismic activity will be incorporated into future analysis.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since 1987 are classified as current NSR..

Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.

- uneconomic areas* — areas classified through a delivered wood cost assessment as unavailable for harvest for economic or terrain-related reasons. Characteristics used to define areas as uneconomic include distance from processing facilities in Fort Nelson, existing road access, difficulty of developing road access where roads do not exist, and the availability of suitable timber. Areas that are considered uneconomic can change over time as a function of changing harvesting technology and economics.
- cultural heritage resources — inventory efforts are ongoing and information is incomplete. Some cultural heritage resource values are likely to have been accommodated in the analysis through area exclusions for other resource values such as riparian reserves. Future analyses are expected to more fully incorporate cultural heritage resource values as inventories are completed and appropriate management strategies are developed.
- future roads, trails, and landings — expected future losses of productive forest land to development. These areas are initially included in the timber harvesting land base, and are subsequently removed as part of the first harvest.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 3 summarizes the areas in each category, and shows the area of the timber harvesting land base.

Uneconomic areas
Areas defined as unavailable for harvest for economic or terrain-related reasons. Characteristics used in defining uneconomic areas include distance from processing facilities, existing roads, difficulty of road access, and availability of suitable timber. Areas considered uneconomic can change over time as a function of changing harvesting technology and economics.

3 Information Preparation for the Timber Supply Analysis

Table 3. Timber harvesting land base definition for the Fort Nelson TSA, 2000

Classification	Area (hectares)	Per cent of total area	Per cent of productive forest area
Total area on inventory file	8 213 731[a]	100.0	
Not managed directly by the Ministry of Forests	213 088	2.6	
Non-forest, non-productive, no typing[b]	3 810 093	46.4	
Total productive forest managed by the Ministry of Forests (Crown forest)	**4 190 550**	**51.0**	**100.0**
Reductions to Crown forest[c]:			
Naturally disturbed areas[d]	107 555		2.6
Non-commercial cover (brush)	511 797		12.2
Non merchantable	169 965		4.1
Low timber productivity	1 875 661		44.7
Alpine (not previously accounted for)	718		< 0.1
Riparian areas* in coniferous stands	83 880		2.0
Riparian areas in deciduous stands	20 061		0.5
Environmentally sensitive areas	29 517		0.7
Range areas	16 110		0.4
Existing roads, trails and landings	4 559		0.1
Stand-level biodiversity (wildlife tree* patches)	68 536		1.6
Seismic areas	14 396		0.3
Uneconomic areas	114 357		2.7
Black spruce-leading stands	248 581		5.9
Total current reductions	**– 3 265 693**	**– 39.8**	**– 77.9**
Current timber harvesting land base (includes 25 521 hectares not satisfactorily restocked (NSR) land)[e] coniferous timber harvesting land base – 522 686 hectares deciduous timber harvesting land base – 402 171 hectares	**924 857**	**11.3**	**22.1**
Future additions			
Future rehabilitation*	2 500	< 0.1	0.1
Future reductions			
Future roads	– 41 755	– 0.5	– 1.0
Long-term timber harvesting land base	**885 602**	**10.8**	**21.1**

a) The total area does not include 1.5 million hectares recently added to the Fort Nelson TSA from the Cassiar TSA.

b) There are 1208 hectares with no typing available included with the non-forest and non-productive area.

c) Reductions were performed in the order listed in the table.

d) Naturally disturbed areas are not satisfactorily restocked (NSR) areas with no record of harvesting history (i.e., naturally-caused NSR).

e) NSR includes current and backlog NSR.

Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes
Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Rehabilitation
Removing all non-commercial cover, preparing the site and stocking it with acceptable, commercially valuable species.

3 Information Preparation for the Timber Supply Analysis

The deciduous timber harvesting land base has not changed significantly from that used as the basis for the last AAC determination, made in 1994. However, the coniferous timber harvesting land base has approximately doubled relative to the area on which the 1994 AAC decision was based. The timber supply analysis method has changed significantly since the previous analysis, completed in 1992, making comparison difficult. However, some fundamental changes are apparent. First, the coniferous timber harvesting land base for this analysis includes spruce-pine stands, and pine-leading coniferous and mixedwood stands, which were not included in the land base used for the 1994 AAC determination. The timber harvesting land base also now contains a much larger area of spruce-leading stands, including mixedwoods.

Some of these differences reflect changes in forest practices, such as the beginning of harvesting in mixedwood stands. Land base changes also stem from differences in methods for defining harvestable areas. The previous analysis employed partial inclusions of both area and volume in different forest types. In this analysis, stands were entirely excluded from or included in the timber harvesting land base depending on the operability, environmental, productivity and merchantability considerations previously discussed. Another difference was associated with exclusions related to delivered wood cost. For the 1992 analysis of coniferous timber supply, delivered wood cost exclusions were based solely on the contribution of coniferous stands. For the current analysis, both coniferous and deciduous stands contributed, which made some areas more economical for harvesting operations (i.e., development, harvesting and transportation costs could be offset by both coniferous and deciduous stands).

Figure 2 shows both the total Fort Nelson TSA area, and the productive forest land base. Almost one-half of the TSA is classified as either non-forest or non-productive forest. The productive forest chart details the categories of forest land and shows that about 78% of the forested land in the Fort Nelson TSA is not within the timber harvesting land base. The most significant reasons that areas are unavailable for harvest include low growth potential, presence of non-commercial brush or non-merchantable tree species, economic inoperability, and natural disturbance, which together account for 66% of the forest land base. An additional 5% is unavailable for harvesting due to environmental sensitivity, and retention of riparian reserves and wildlife tree patches.

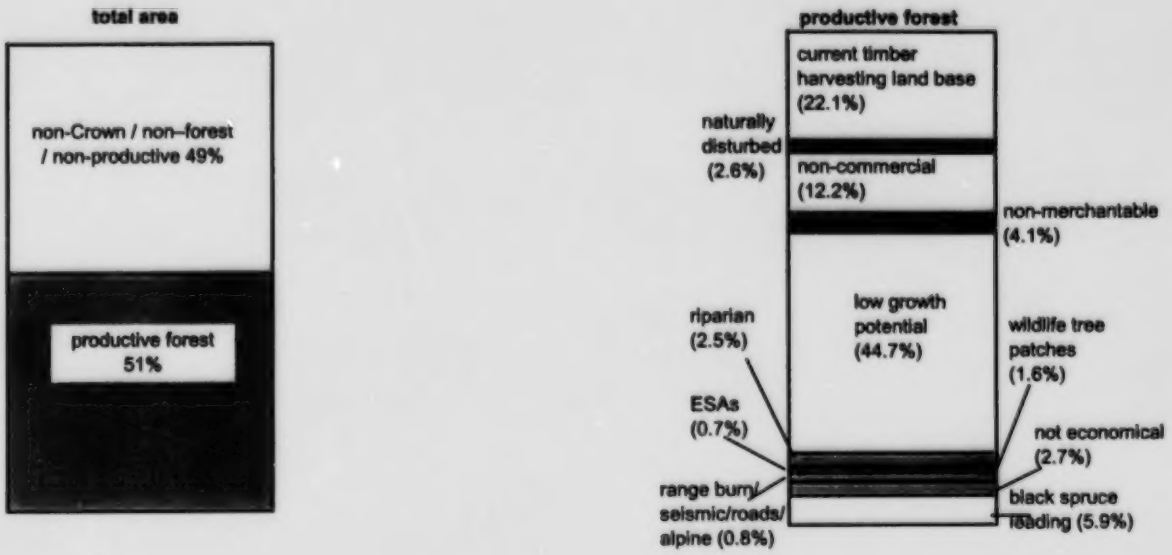


Figure 2. Composition of the total and productive forest land bases — Fort Nelson TSA, 2000.

Wildlife range, seismic activity, existing roads, and alpine ecosystems, comprise a further 1% of the forest area and are excluded from the timber harvesting land base. As discussed previously, black spruce-leading stands are not normally harvested and are therefore also excluded.

After all other land base exclusions, about 22% of the productive forest is currently considered available for timber harvesting (including NSR).

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Stands dominated by spruce species cover about 50% of the timber harvesting land base, while aspen dominates on about 38%. Pine, cottonwood and balsam dominate on 7.5%, 5% and less than 1% of the area, respectively.

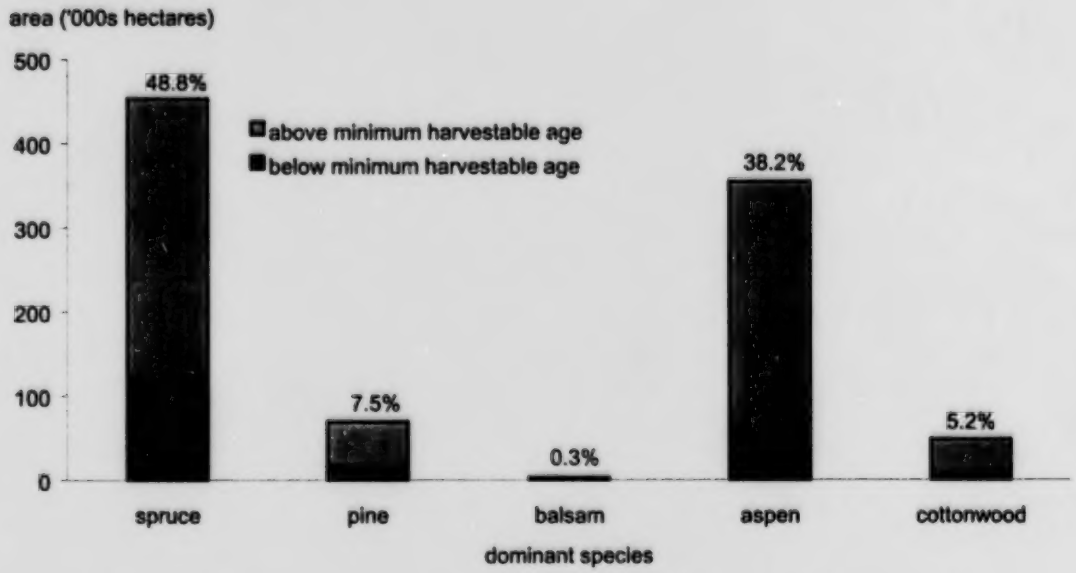


Figure 3. Area by dominant species — Fort Nelson TSA timber harvesting land base, 2000.

Figure 3 also shows the proportion of area of each species that is either younger or older than the applicable minimum harvestable age (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In total, about 78% of the timber harvesting land base is currently at or above minimum harvestable age, while an additional 7% will reach minimum harvestable age within the next 10 years. There is some variation around the average current proportion among the species groupings: 84% of balsam and aspen stands, 80% of cottonwood stands, 75% of pine stands and 76% of spruce stands are currently older than the minimum harvestable age.

3 Information Preparation for the Timber Supply Analysis

Figure 4 shows the distribution of site productivity within the timber harvesting land base by leading species. Stands classified as having low productivity are not currently considered economical to harvest, and were excluded from the timber harvesting land base. The site index* threshold for each species is listed in Table A-6 of Appendix A.

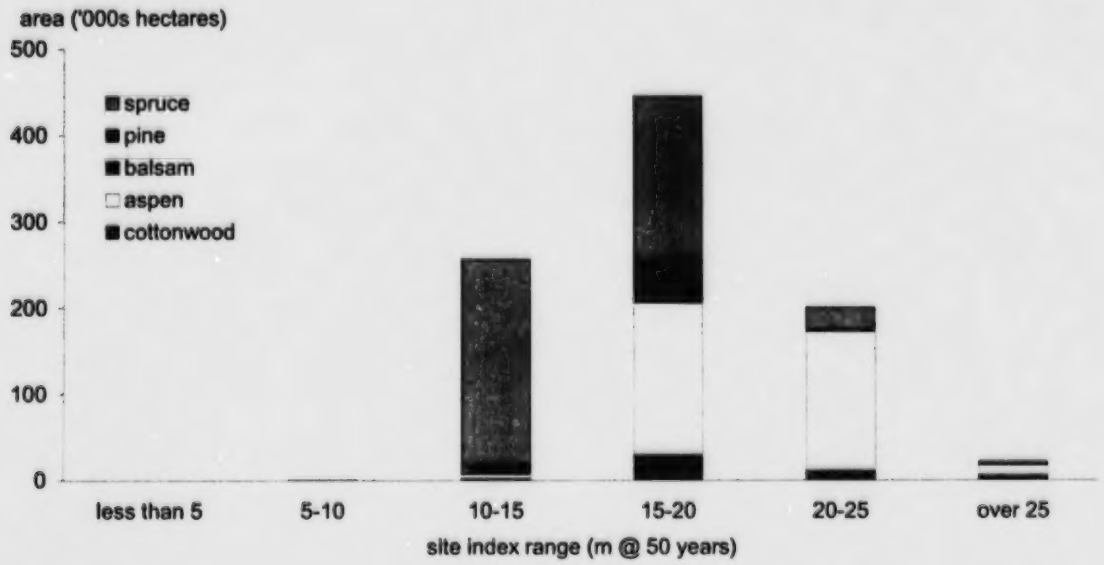
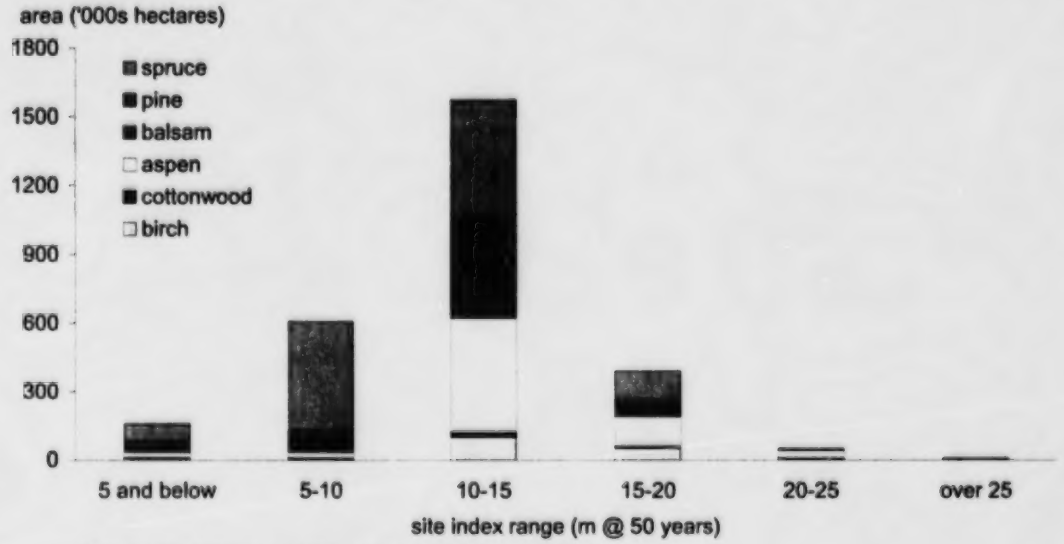


Figure 4. Site productivity by leading species — Fort Nelson TSA timber harvesting land base, 2000.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Figure 5 shows the distribution of site productivity within the forested area excluded from the timber harvesting land base. The timber harvesting land base covers about one-fifth of the total forested area, and on average consists of the more productive sites within the Fort Nelson TSA.



Note scale change on area axis compared to Figure 4.

Figure 5. Site productivity by leading species — forested area excluded from the Fort Nelson TSA timber harvesting land base, 2000

Relatively small decreases in the cost of harvesting stands or small increases in product selling price could result in the inclusion of stands with lower site productivity. The information summarized in Figure 5 suggests that the size of the timber harvesting land base could increase significantly if stands with a slightly lower site productivity were included in the timber harvesting land base. Likewise, relatively small increases in costs of harvesting or reductions in product selling price could result in a smaller timber harvesting land base, as the minimum site productivity required to make a stand economical would be greater.

Figure 6 shows the current age class distribution of the Fort Nelson TSA forest land base. Within the timber harvesting land base, a substantial portion of stands are in mature (28%) or old (36%) seral stages*. About 6% of stands are early seral*.

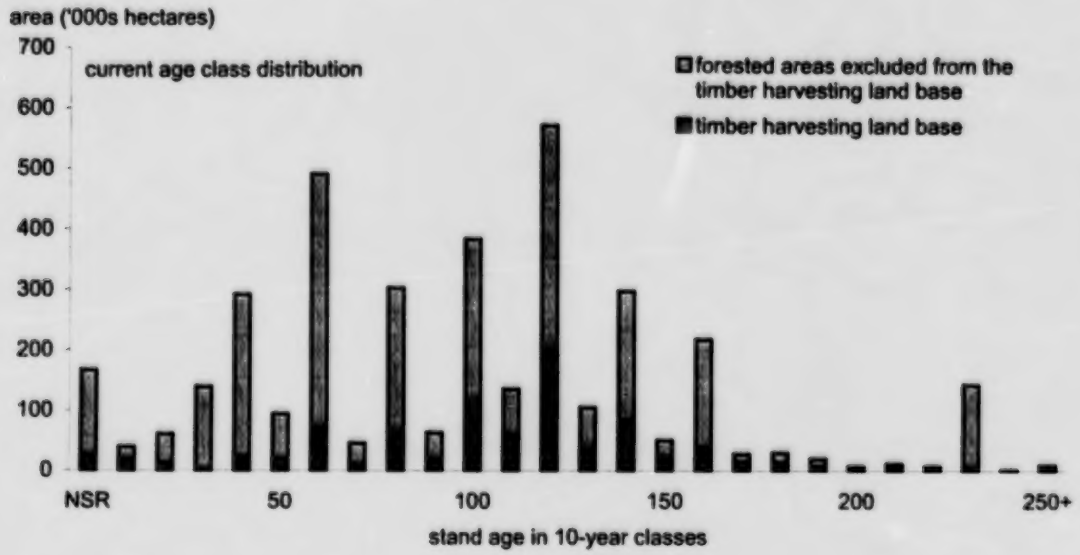


Figure 6. Current age class composition — Fort Nelson TSA productive forest land base, 2000.

Through their contribution to non-timber objectives, such as old-forest attributes, forested stands outside of the timber harvesting land base may affect timber supply. In the case of the Fort Nelson TSA, a significant proportion of the forested land base is outside the timber harvesting land base. Of the excluded forest area, about 14% is old seral*, 28% is mature seral* and 16% is early seral.

Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Early seral
Stands are defined as early seral if they are younger than: 40 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 40 years for coniferous stands and 20 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.

Old seral
Stands are defined as old seral if they are older than: 250 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 140 years for coniferous stands and 100 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.
Mature seral
Stands are defined as mature seral if they are older than: 120 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 100 years for coniferous stands and 80 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.

Table 4. Current seral stage conditions — Fort Nelson TSA, 2000

	Seral stage	Timber harvesting land base (%)	Excluded from timber harvesting land base (%)
Coniferous	Early	11	21
	Immature	32	31
	Mature	36	36
	Old	21	12
Deciduous	Early	3	8
	Immature	24	65
	Mature	18	11
	Old	55	16
Total	Early	7	17
	Immature	30	41
	Mature	28	28
	Old	35	14

Only 4% of the timber harvesting land base contains stands that are currently shorter than three metres in height. Only in two landscape units*, representing less than 1% of the timber harvesting land base, is the area not meeting the 3-metre green-up* requirement currently approaching 30%. Given current conditions, forest cover requirements* limiting the area covered by recently harvested stands (discussed in Section 3.3, "Management practices") are not likely to be a constraining factor for timber supply. This issue will be discussed further in Section 6.2, "Uncertainty in approximations of adjacency guidelines."

Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).

3.2 Timber growth and yield

Timber growth and yield refers to the prediction of the growth and development of forest stands over time. Forest stands have many characteristics that change over time (for example, number of trees per hectare, tree diameter, tree height, species composition). Since timber supply analysis concentrates on timber volumes available over time, the most relevant measure for this analysis is volume per area (in British Columbia, cubic metres per hectare). An estimate of timber volume in a stand assumes a specific utilization level, or set of dimensions, that establish the minimum tree and log sizes that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree.

Two growth and yield models were used to estimate timber volumes for the Fort Nelson TSA analysis. The variable density yield prediction (VDYP) model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in existing stands, and for stands regenerating primarily to deciduous, or mixedwood stands. The table interpolation program for stand yields (TIPSY), developed by the B.C. Forest Service, Research Branch was used to estimate yields for the coniferous managed stands. All predominantly coniferous stands are assumed to grow according to managed stand yield estimates from TIPSY following future harvest.

Volume estimation and prediction is subject to uncertainty due to uncertainty in inventories which form the basis for estimating site productivity, and to limited experience with second growth in British Columbia. Sensitivity analyses described in Section 6, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates* for existing stands, the current timber inventory on the timber harvesting land base is approximately 114 million cubic metres for coniferous-leading stands and 89 million cubic metres for deciduous-leading stands. About 112 million cubic metres of coniferous-leading stands, and 87 million cubic metres of deciduous–leading stands are considered merchantable; that is, older than minimum harvestable age and meeting the utilization standards.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

3.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis process. The focus of the timber supply review is to assess timber supply based on current management practices as implemented in operational plans for the area. In addition to land base deductions to account for riparian reserves, environmentally sensitive areas, sites with low productivity for timber growth, and delivered wood cost, staff in the Fort Nelson Forest District provided descriptions for the following management practices:

- Silviculture practices — reforestation activities required to establish free-growing* stands of acceptable tree species. All coniferous stands (37% of the timber harvesting land base), are expected to be planted to spruce or pine, depending on site conditions. All mixedwood and deciduous stands (33% and 30% of the timber harvesting land base respectively), are expected to regenerate to pre-harvest species compositions.
- Forest health and unsalvaged losses* — timber losses to fire and insects are expected to average 64 000 cubic metres per year from the timber harvesting land base (58 000 cubic metres from the coniferous and 6000 cubic metres for the deciduous land base).
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Cutblock adjacency* and green-up — in the Fort Nelson TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (three metres in height), before adjacent stands may be harvested. Furthermore, the area in the timber harvesting land base that does not meet green-up conditions cannot exceed 39% in each landscape unit (Figure 7). The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time.
- Maintenance of wildlife habitat — all areas identified with high wildlife sensitivity (ESA_W1) in the inventory have been excluded from harvest. All areas identified with a moderate wildlife sensitivity (ESA_W2) and having significant caribou or mountain goat habitat are also excluded from harvest.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.

3 Information Preparation for the Timber Supply Analysis

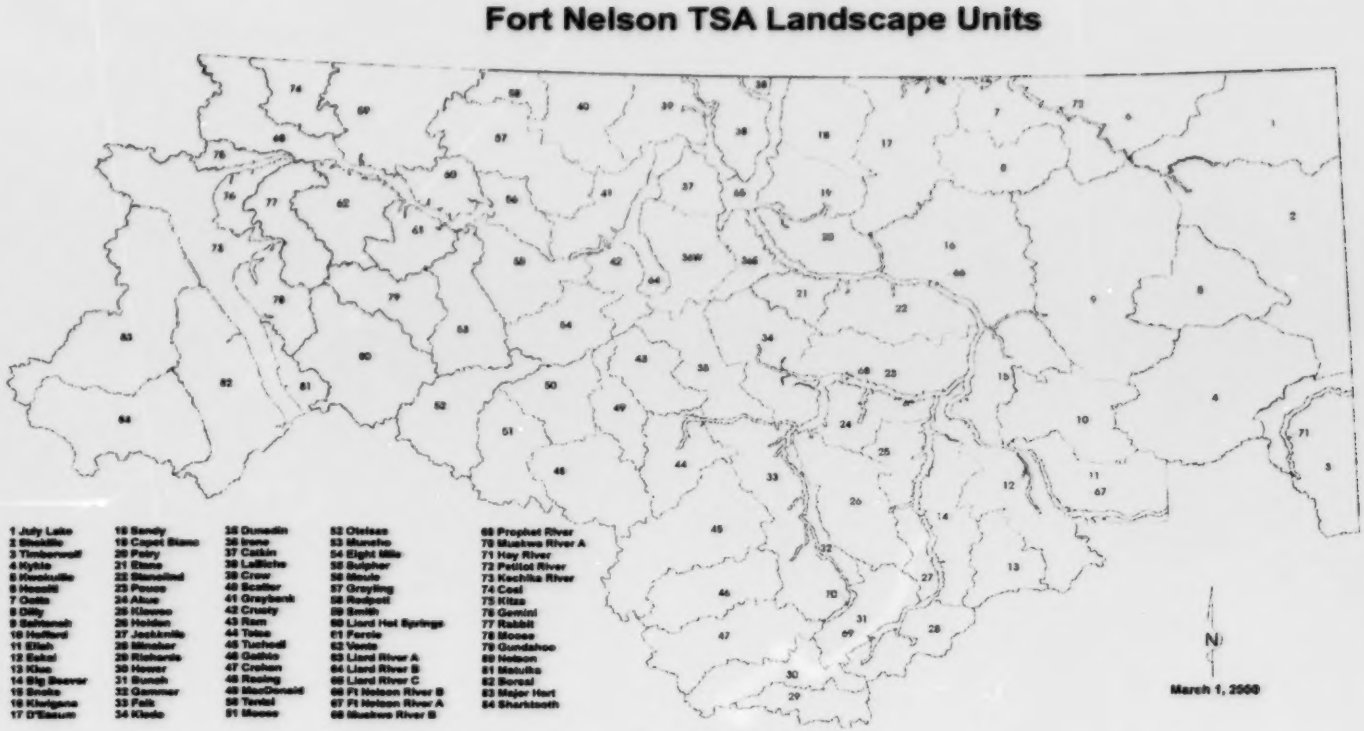


Figure 7. Map of the landscape units in the Fort Nelson TSA.

- Management for visual quality — maintaining visual quality requires that visible evidence of harvesting be kept within limits. The areas that have visual quality objectives (VQO)*, which cover 358 341 hectares of forested area in the Fort Nelson TSA, are shown in Figure 1. The majority of the visually sensitive forest (297 808 hectares) is assigned a partial retention class. At most, 10% of partial retention visually sensitive area within a landscape unit may be covered by stands less than five metres tall (the visual green-up). The remainder of the visually sensitive area is classified as retention (5074 hectares), modification (43 309 hectares) and maximum modification (12 150 hectares), where at most 3%, 20.5% and 33% of the visually sensitive area within a landscape unit may be covered by stands less than five metres tall. About 33% (116 923 hectares) of the visually sensitive forest is within the timber harvesting land base.
- Minimum harvestable ages — the time it takes for stands to grow to a merchantable condition. Minimum harvestable ages for this analysis were set at the age at which stands reach a minimum volume. The minimum harvestable age defines the youngest age at which a specific type of stand is expected to become harvestable. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other stands, forest cover objectives* (e.g., for adjacency, old growth and visual quality), and overall timber harvest targets.
- Landscape-level biodiversity* — to maintain biological diversity at the landscape level, requirements are placed on the proportion of area within each biogeoclimatic variant* in each the landscape unit that must be covered by stands with mature plus old-, or old-forest characteristics. Mature ages (defined as 80 years or 100 years in the Fort Nelson TSA), old ages (100, 140 or 250 years), and the proportion of area required in mature and old conditions depend on the natural disturbance type (NDT)*, biogeoclimatic zone and variant and designated biodiversity* emphasis. As biodiversity emphasis has not yet been designated, an average biodiversity emphasis (45% lower, 45% intermediate and 10% higher) was assumed.

More detailed descriptions of these management practices and the assumptions used to assess their impacts on timber supply are included in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).
Landscape-level biodiversity
The Forest Practices Code Biodiversity Guidebook *provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.*

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.
Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

4 Timber Supply Analysis Methods

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Fort Nelson TSA under current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service was used for the analysis. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in generating harvest forecasts (supply of timber over time) using a set of forest management assumptions. The simulation model uses information about the timber harvesting land base, timber volumes, and the management regime to represent how forests grow and are harvested over hundreds of years. There is no presumption that the future can be known hundreds of years from now; the analysis horizon simply reflects that forest-level changes often occur over very long time periods. Generally, only the results for the first 250 years are shown graphically in this report because the projected harvest remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to specified yield projections and are harvested according to either a volume target or a specified objective set by the analyst, such as harvest volume maximization. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of cutblock adjacency and green-up prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age, or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implications of a particular timber harvesting regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports rather than hinders sustainable forest management in the field.

5 Results

This section provides the results of timber supply analysis based primarily on the current forest practices described in Section 3, "Information Preparation for the Timber Supply Analysis." However, as outlined in Section 2, there are critical uncertainties related to the contribution of both black spruce and mixed species stands to the timber supply in the Fort Nelson TSA. Section 5 therefore also provides timber supply analysis results to help assess the implications of the critical issues.

In addition to the two critical issues, there are uncertainties about other land base, growth and yield and management inputs used in the analysis. To assess the potential timber supply impacts of these uncertainties, several sensitivity analyses were performed. The current management results were used as the base case for comparison when assessing the effects of uncertainty on timber supply. The results of these analyses are discussed in Section 6, "Timber Supply Sensitivity Analyses." The base case provides only part of the timber supply picture for the Fort Nelson TSA, and should not be viewed in isolation of the sensitivity analyses.

5.1 Base case/current management—black spruce stands not included in coniferous supply

The best assessment of current forest practices, as described in Section 3, indicates that black spruce–leading stands are not targeted for harvesting, and do not contribute to the coniferous timber harvesting land base. Conversely, given recent performance in mixed coniferous-deciduous stands, these mixedwood types do contribute to the harvesting land base. Figure 8 shows the harvest forecasts corresponding to this description of current management for the Fort Nelson TSA. The analysis indicates that a coniferous harvest of 1 376 000 cubic metres per year, approximately 230% of the current coniferous AAC, can be maintained over the long term. The analysis also indicates that a deciduous harvest of 900 000 cubic metres per year, equivalent to current allowable annual harvest for the deciduous land base, can be maintained over the long term.

Unsalvaged losses to natural forces such as insects and fire are estimated to be 64 000 cubic metres per year (58 000 cubic metres per year of coniferous and 6000 cubic metres per year of deciduous) for the entire 250-year horizon.

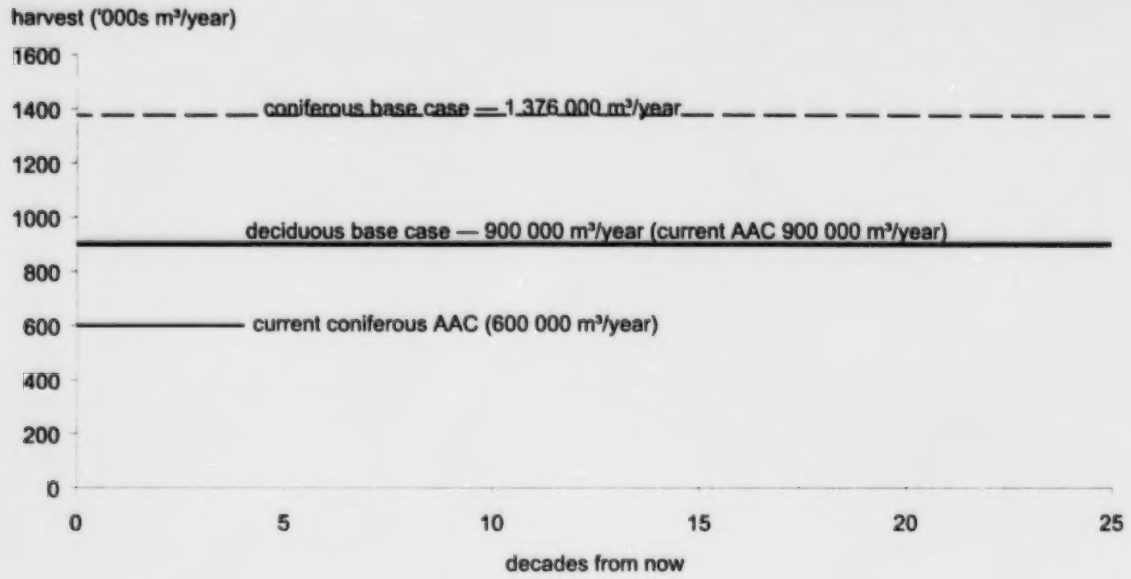


Figure 8. Current management harvest forecasts for the Fort Nelson TSA, 2000.

Since they closely reflect current management practices, the harvest forecasts shown in Figure 8 will be used as the "base case" for comparison with analysis of the critical issues, and later for sensitivity analysis.

The base case timber supply forecasts are defined mostly by the long-term productivity of the land base, particularly for deciduous-leading stands. That is, the forecasts are even-flow projections at the long-term harvest level* for the coniferous and deciduous land bases. The long-term harvest level is the harvest rate that can be achieved while maintaining the total timber growing stock* on the timber harvesting land base at an even level on average over the long term (see Figure 9). An even growing stock indicates that harvesting can continue at the corresponding harvest level in perpetuity. A continually increasing growing stock would indicate that the timber is being harvested below the productive capability of the land. A continually declining growing stock would signify that the timber is being harvested above the productive capability of the land.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

Growing stock
The volume estimate for all standing timber, at a particular time.

Figure 9 shows a projection of timber inventory volumes over time corresponding to the current management harvest forecasts. Coniferous total growing stock for the timber harvesting land base declines over the next 11 decades from almost 114 million cubic metres as the oldest of the existing mature stands are harvested and replaced with younger stands. The average coniferous growing stock over the long term for the base case is 69 million cubic metres.

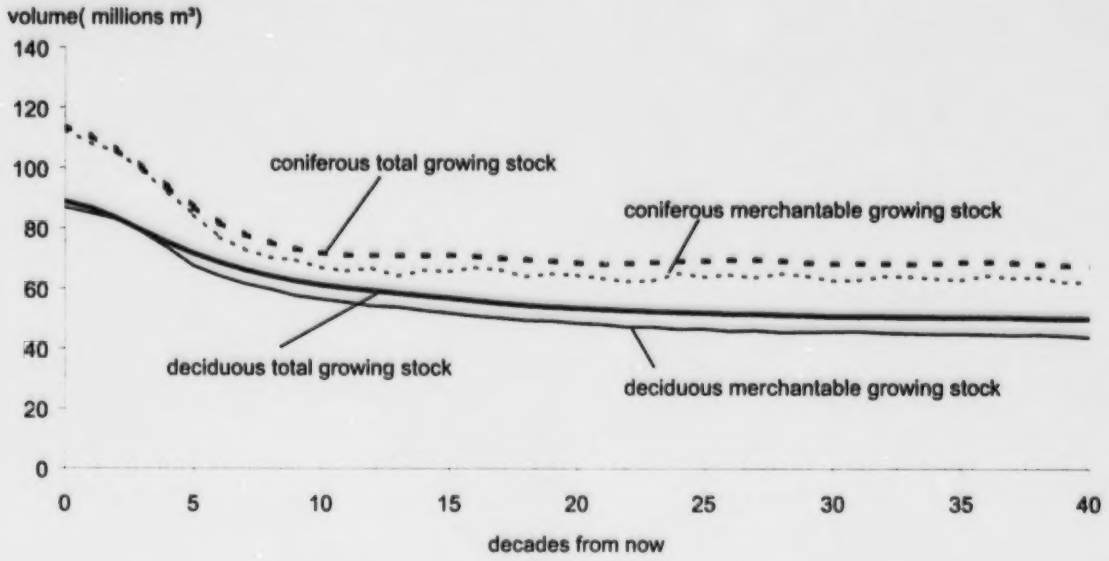


Figure 9. Changes in growing stock on the timber harvesting land base over time — Fort Nelson TSA base case, 2000.

The total deciduous growing stock on the timber harvesting land base gradually declines for about 400 years from almost 89 million cubic metres before leveling off and reaching the steady state of about 50 million cubic metres.

Harvest flow patterns other than the base case even-flows are possible. Since the base case forecasts* are defined mostly by the long-term level, the short- and medium-term timber supplies shown in the base case are not at the maximum level. Some alternative forecasts, with different initial harvest levels and different transitions to the long-term harvest level, are described in Section 6.1, "Alternative harvest flows over time."

Base case forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

5.1.1 Transition from existing to managed stands

An important factor defining timber supply is the timing of the transition of harvesting from existing, mostly older stands, to managed stands. Figure 10 displays the contributions of existing and regenerated (managed) stands to the coniferous base case harvest forecast. In the figure, all stands are classified as managed after their first harvest. Only some stand types (pure coniferous spruce and pine) are projected using managed stand yield tables, mostly due to lack of information on growth of managed mixedwood and pure deciduous stands. Analysis results indicate that coniferous timber supply will begin relying on regenerated stands approximately 110 years from now, with the majority of the harvest coming from regenerated stands by 120 years from now. The existing-to-managed transition for the deciduous land base (not shown in Figure 10) is projected to occur one decade later than for the coniferous land base.

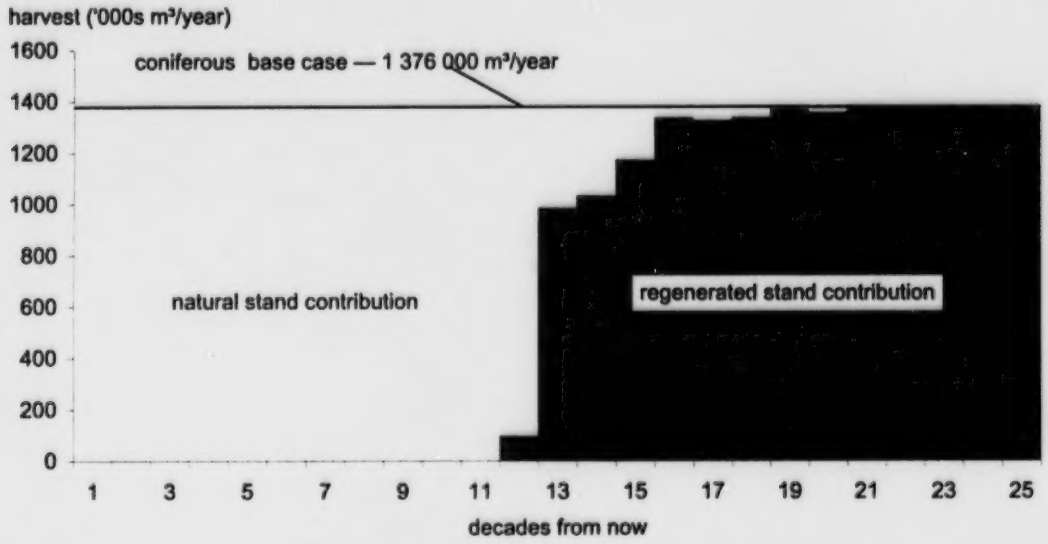


Figure 10. Contribution of existing and regenerated stands to the coniferous harvest forecast — Fort Nelson TSA base case, 2000.

The average growth rate projected from regenerated stands over the long term is about 2.52 cubic metres per hectare per year (2.73 cubic metres per hectare per year from coniferous and 2.25 cubic metres per hectare per year from deciduous stands). These average growth figures were derived by dividing the total timber supply, including non-recoverable losses, by the timber harvesting land base area.

Theoretically, if all stands were harvested at the age of maximum productivity, an average annual harvest rate of approximately 2 599 000 cubic metres (1 568 000 cubic metres of coniferous and 1 031 000 cubic metres of deciduous-leading stands) could be achieved in the long term. However, the long-term harvest level is below this theoretical maximum productive capacity of the timber harvesting land base. The maximum is not achieved because visual quality objectives, maximum disturbance limits within landscape units, and the objective of maintaining an even harvest flow over time result in stands not being harvested at the time of maximum productivity.

5.1.2 Area, average volume, and average age harvested

Figure 11 shows the annual area harvested over the next 250 years under the base case harvest forecasts (the areas are not adjusted to account for unsalvaged losses, which were deducted as a volume from the harvest forecasts). The area harvested on the deciduous land base is projected to increase gradually from 3000 hectares per year over the next 50 years, to 3300 hectares per year after 250 years.

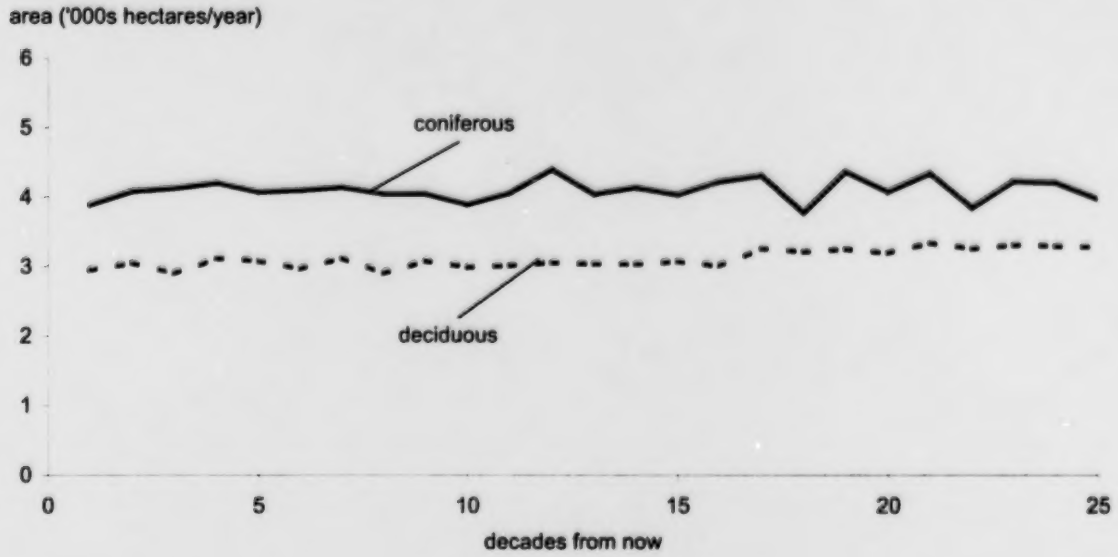


Figure 11. Area harvested over time — Fort Nelson TSA base case, 2000.

The area harvested on the coniferous land base remains fairly constant, averaging 4070 hectares per year over the next 50 years, and 4130 hectares per year from 100 to 250 years from now.

Even though the harvest levels for both deciduous and coniferous species remain fairly constant throughout the analysis horizon, the area harvested fluctuates slightly because over time the harvests are projected to come from stands of different species and age.

Figure 12 shows the average timber volume per hectare harvested over the same period. These average volumes were derived using the total volume harvested including unsalvaged losses, since it was not possible to adjust area harvested figures to account for the area corresponding to unsalvaged losses. The harvested volume for coniferous stands decreases over time from an average of 352 cubic metres per hectare during the first 50 years, to 348 cubic metres per hectare during the last 150 years. The harvested volume for deciduous stands decreases from an average of 300 cubic metres per hectare during the first 50 years, to 285 cubic metres per hectare during the last 150 years. Overall, the average volume per hectare harvested over time is forecast to remain relatively constant.

For this analysis it was assumed that pure coniferous stands will realize significant volume gains upon regeneration as a result of management activities, and will grow according to managed stand yield tables. For the analysis, it was also assumed that regenerated deciduous and both deciduous- and coniferous-leading mixedwood stands will have similar growth to the stands that existed prior to harvest; no significant volume productivity gains due to management are expected in these stands upon regeneration. Refer to Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for more details regarding regeneration assumptions used in this analysis.

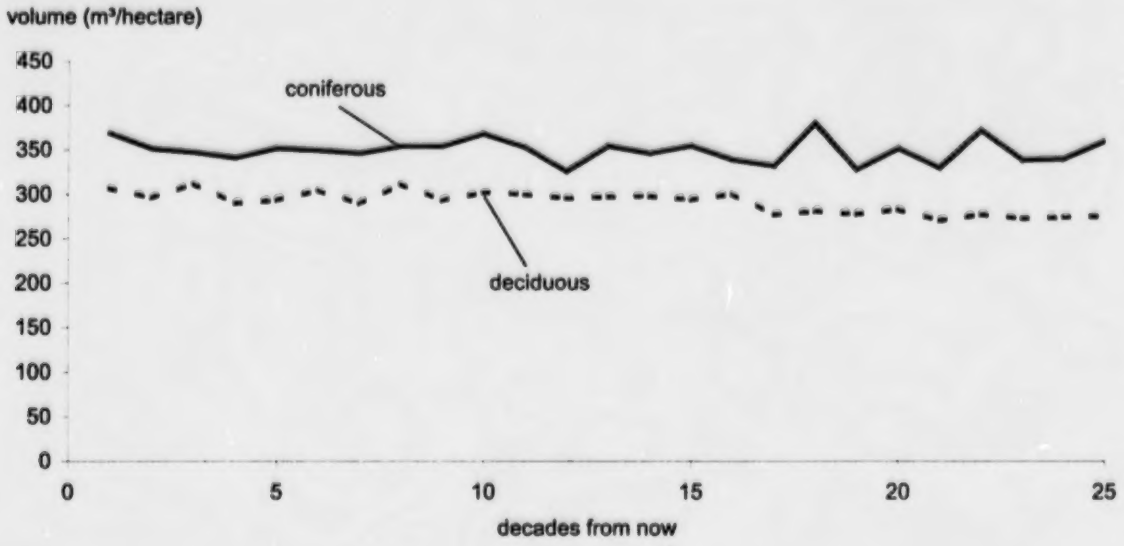


Figure 12. Average volume per hectare harvested over time — Fort Nelson TSA base case, 2000.

Figure 13 tracks the change in the average age at which stands are harvested under the base case harvest forecasts. The harvest comes from older unmanaged stands during the initial 100 years, with an average harvested age of about 168 years for coniferous stands and 156 years for deciduous stands. Between 100 and 200 years from now, the harvest comes from a mixture of older unmanaged stands and younger regenerated stands. After 200 years all projected harvests are from regenerated stands, and the average harvested age declines to just under 120 years for both coniferous and deciduous stands. (It should be noted that not all of the regenerated stands harvested after 200 years from now are assumed to grow according to managed stand yield predictions—see Figure 15). The average harvested age over the long term is older than the minimum permissible harvestable ages, which range from 45 to 114 years depending on species and site productivity.

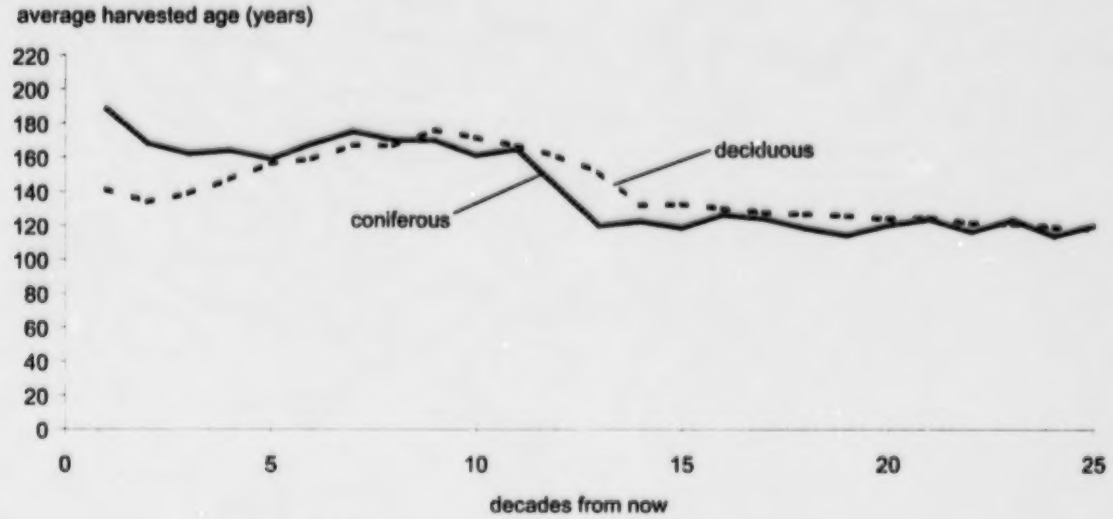


Figure 13. Average harvested age over time — Fort Nelson TSA base case, 2000.

For the entire harvest forecast, few stands are harvested at the minimum harvestable age due to the high proportion of older stands available for harvest, the higher harvest priority given to older stands, other resource objectives, and the objective of maintaining an even harvest flow over time. The average harvested age of the regenerated stands would be about 69 years for coniferous and 61 years for deciduous stands, if all stands were being harvested at minimum harvestable ages.

The increase in the deciduous harvest ages over the first 80 years is notable. There is concern that deciduous stands may become increasingly susceptible to fire, disease, and insects as they age beyond maturity. Further, the inventory may not reflect successional changes that have occurred since the TSA was last inventoried. However, there is no conclusive information available at this time that would either allow explicit modelling of deciduous stand dynamics, or indicate clearly that this result suggests a risk to timber supply. Fort Nelson Forest District staff note that the aspen stands in the TSA appear to retain the majority of their volume to older ages than similar stands elsewhere in the province. This trend has not been specifically quantified, and the issue of health and aging in deciduous stands may warrant attention in the future. New information can be incorporated into inventory updates that will be used in future timber supply analyses.

5.1.3 Age class composition over time

The charts in Figure 14 show how the age composition of the Fort Nelson TSA timber harvesting land base changes over the next 250 years under the base case harvest forecast.

Currently, most of the timber harvesting land base (78%) consists of stands at or above minimum harvestable age. The forested land base also contains stands that have been excluded from the timber harvesting land base as shown in Figure 6. While these excluded forested stands range significantly in age, enough have older forest characteristics so that initially, very little of the timber harvesting land base must be retained to achieve requirements for old-seral forest. After 100 years the timber harvesting land base has achieved a relatively even age class distribution, with very little older forest remaining. The excluded forest has also aged, thus even more of the old and mature requirements are met from the excluded forest after 100 years (Figure 15).

Most of the requirements for old and mature forest attributes within the Fort Nelson TSA are currently achieved. The analysis indicates that over time, almost all old and mature forest requirements for the Fort Nelson TSA are provided by stands outside of the timber harvesting land base. Thus, *Forest Practices Code* biodiversity mature and old seral stage objectives do not appear to limit the long-term harvest level that can be achieved on the timber harvesting land base.

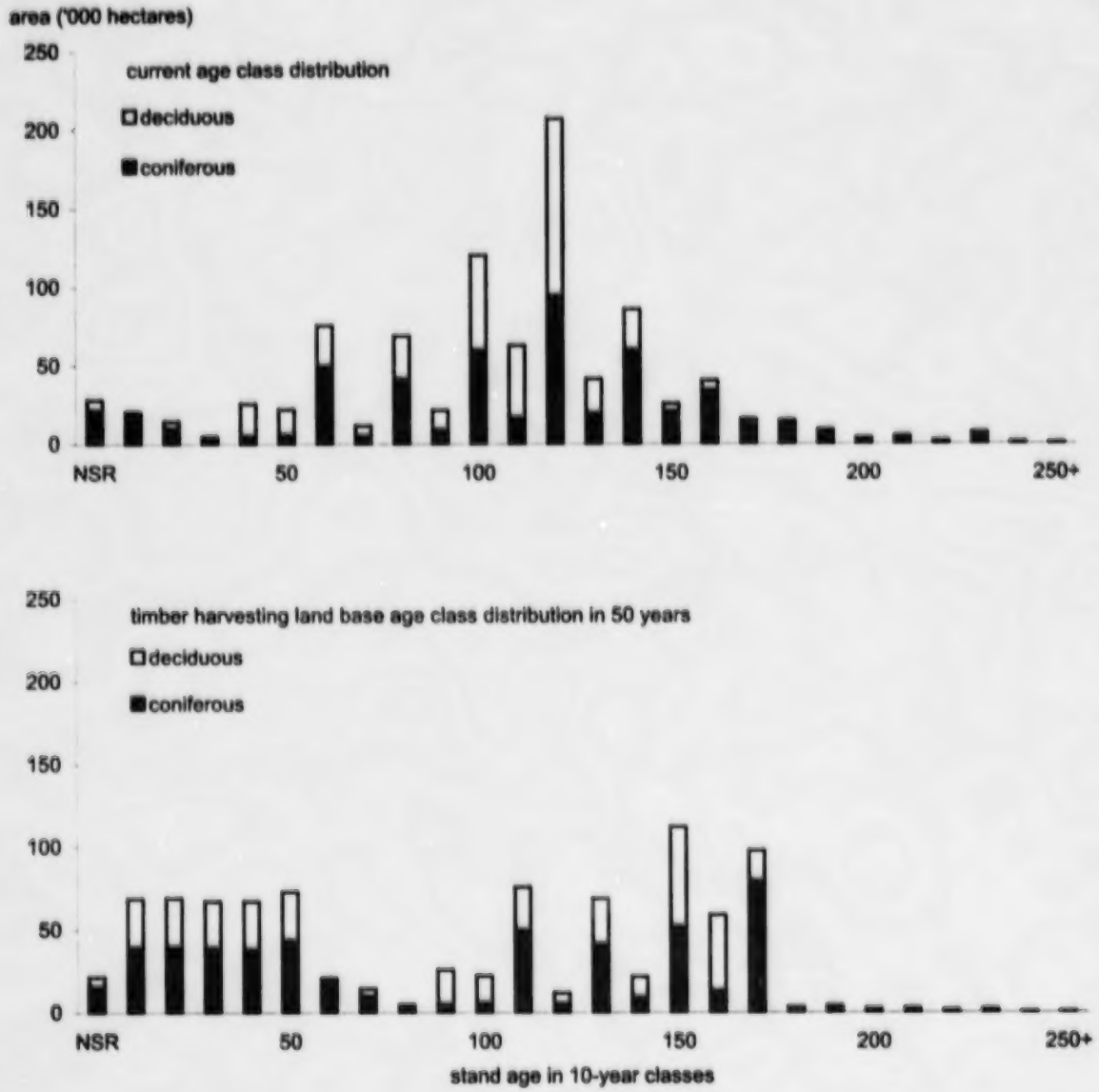


Figure 14. Changes in age composition of the timber harvesting land base over time — Fort Nelson TSA base case, 2000.

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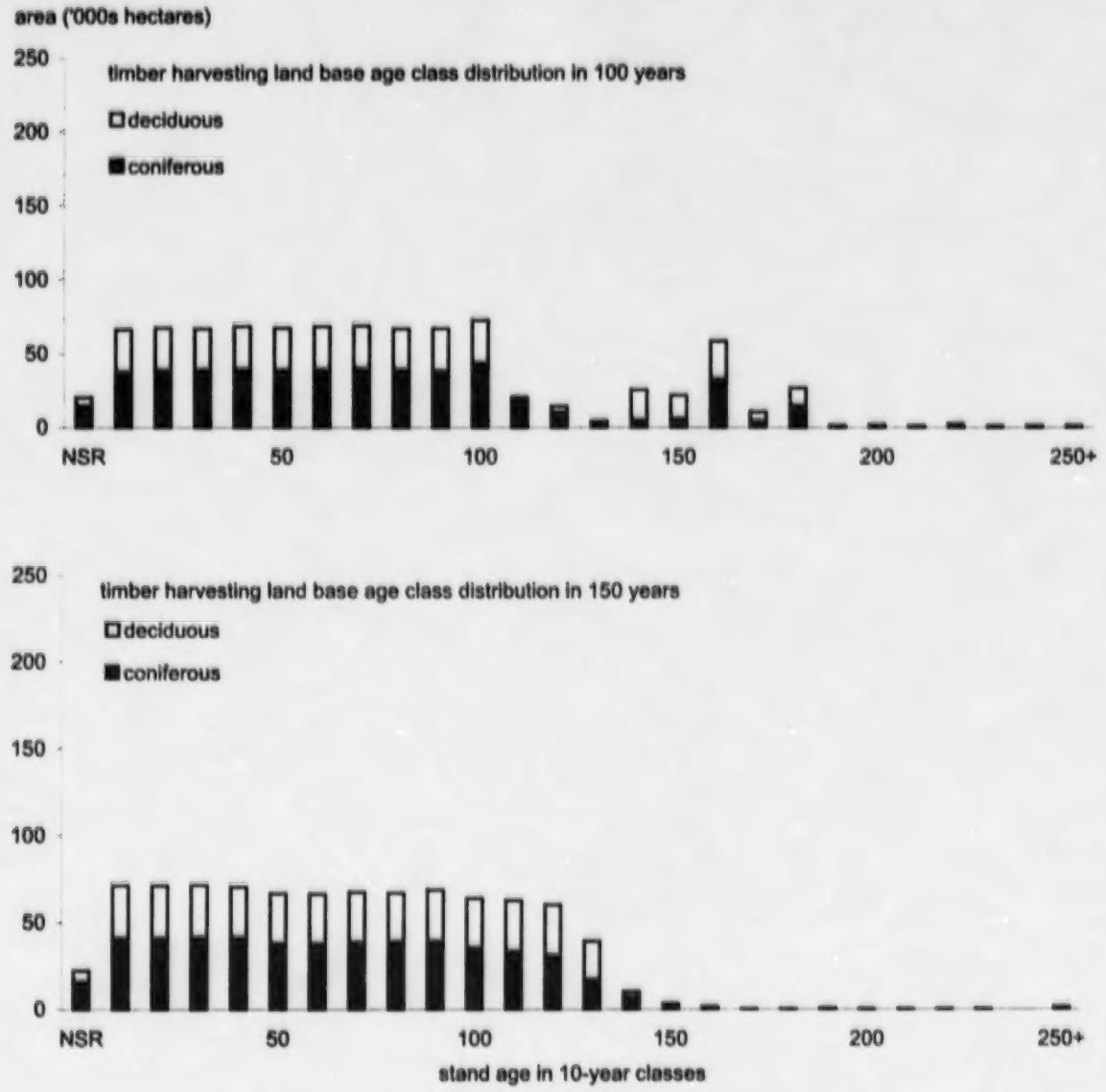

Figure 14. Changes in age composition of the timber harvesting land base over time — Fort Nelson TSA base case, 2000.

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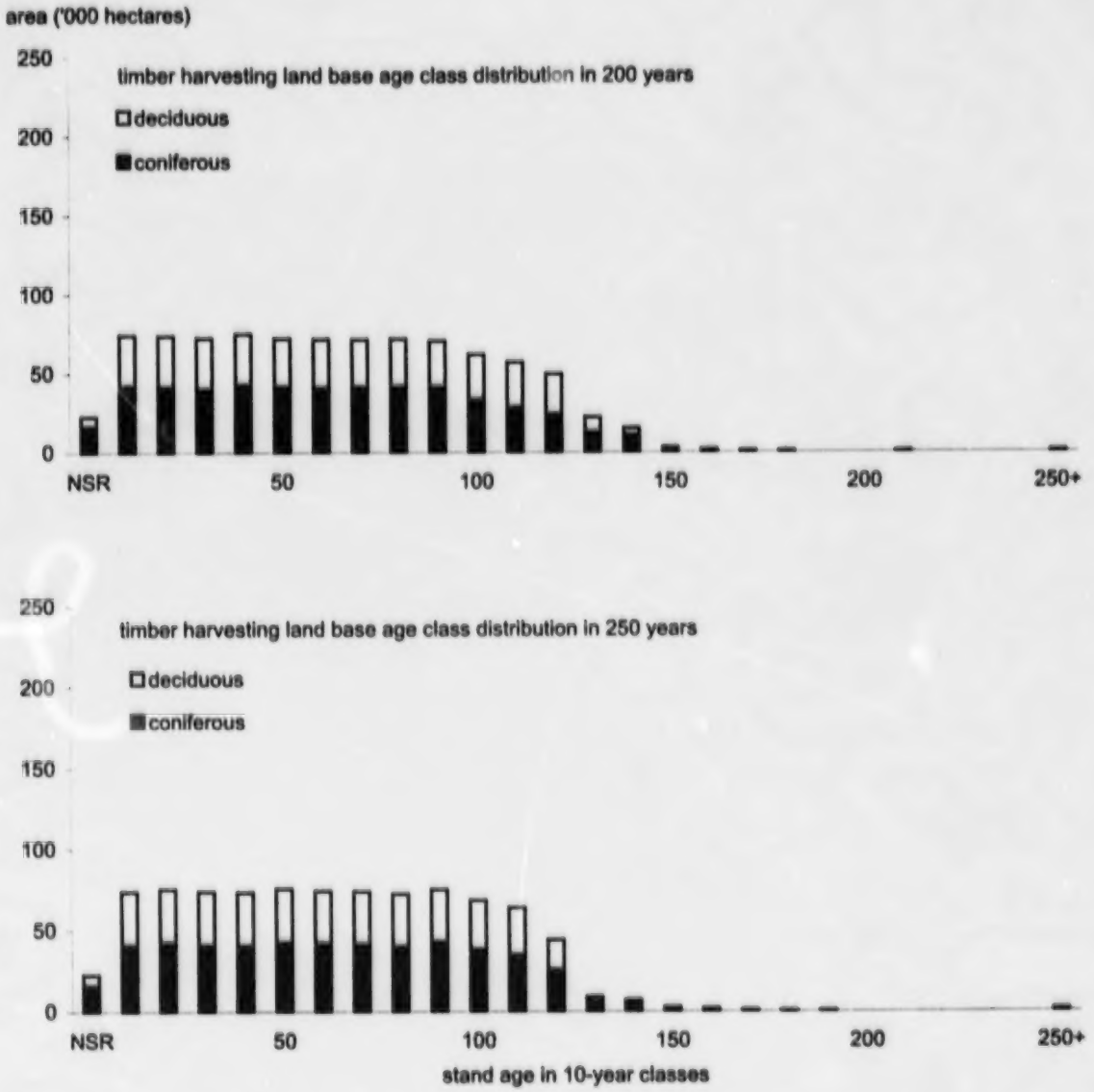

Figure 14. Changes in age composition of the timber harvesting land base over time — Fort Nelson TSA base case, 2000.

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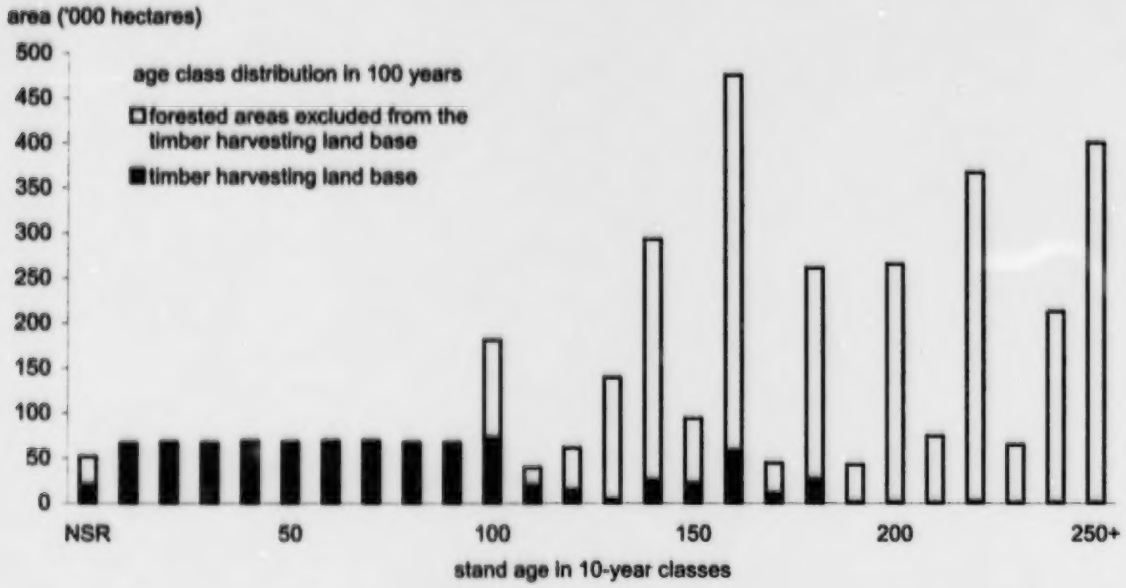


Figure 15. Age class composition of forest within and outside the timber harvesting land base in 100 years — Fort Nelson TSA base case, 2000.

5.2 Critical issue 1: black spruce stands included in coniferous supply

As noted in Section 2.1, harvesting is not currently directed at black spruce-leading stands, and given current uncertainties about inventory classification, economic values and reforestation difficulties, their contribution to timber supply is highly uncertain.

A total of 248 580 hectares of black spruce–leading stands remaining after all other land base exclusions were deducted from the timber harvesting land base for the base case (see Table 3). Addition of this area would increase the coniferous timber harvesting land base by 47.6%, and the total timber harvesting land base by 26.9%. Figure 16 shows that if the area classified in the inventory as black spruce–leading stands were in the timber harvesting land base, the coniferous timber supply would increase by 30.5% to 1 795 000 cubic metres per year for the first 160 years of the analysis horizon. Over the long term, the coniferous supply would increase to 1 838 000 cubic metres per year, 33.6% above the base case level. Deciduous timber supply would not be affected by addition of black spruce stands to the timber harvesting land base.

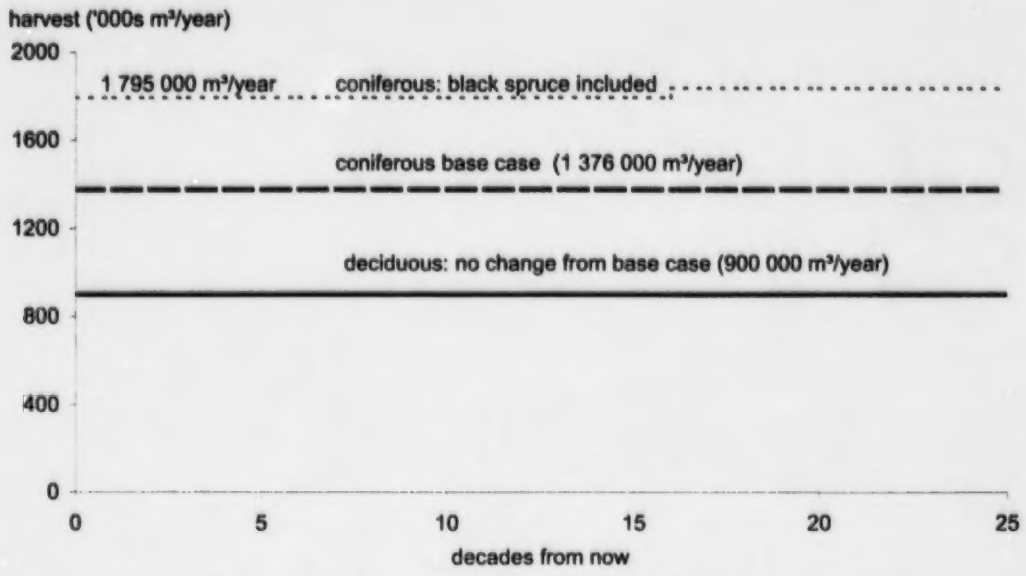


Figure 16. Harvest forecasts if black spruce-leading stands are included in the timber harvesting land base — Fort Nelson TSA, 2000.

For the reasons discussed in Section 2.1, such as uncertainties about the accuracy with which current inventory information distinguishes between black spruce forest and interspersed swamp, these results should be interpreted with great caution. The degree to which all or some of the black spruce stands could potentially contribute to timber supply is highly uncertain at this time. The results do suggest, however, that there may be opportunities to increase timber supply in the future. Any increases based on black spruce-leading stands would require acquisition of better site specific information, and demonstrated performance in these forest types.

5.3 Critical issue 2: mixedwood stands excluded from timber supply

Mixedwood stands are comprised of both coniferous and deciduous trees. Section 2, "Critical Issues" provided a discussion of some of the uncertainties regarding the contribution of mixedwood stands to both coniferous and deciduous supply. These uncertainties relate to potential lack of accounting for species composition changes due to succession, and to the appropriate silvicultural practices (e.g., species choice) to employ in these stands. While harvesting in mixedwood stands has increased recently, there is still uncertainty about the degree to which these stands will continue to contribute to timber supply.

The base case timber harvesting land base includes 183 517 hectares of coniferous-leading mixedwood stands, and 127 047 hectares of deciduous-leading mixedwood stands. Figure 17 displays the impacts on timber supply of excluding all mixedwood stands from the timber harvesting land base. The coniferous harvest forecast would be 27.5% lower than the base case harvest projection, while the reduction in the coniferous land base would be 35.1%. Without mixedwood stands, the projected deciduous base case harvest of 900 000 cubic metres per year could be maintained for 30 years, but the long-term level would be 33.2% lower than the base case projection. With mixedwood stands excluded, the deciduous land base would be 31.6% smaller than in the base case.

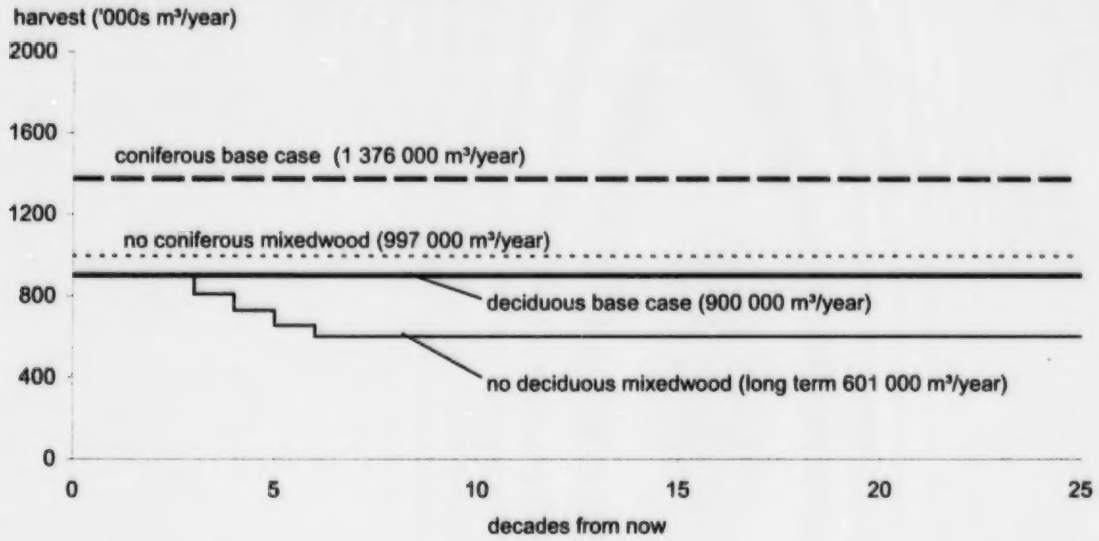


Figure 17. Harvest forecasts if mixedwood stands are removed from the timber harvesting land base — Fort Nelson TSA, 2000.

For coniferous stands, the reason for the discrepancy between the land base (35.1%) and timber supply (27.5%) reductions is related to assumptions regarding yields for regenerated stands. In the base case, only pure coniferous stands were assumed to grow according to higher-yield managed stand yield tables after harvest and regeneration. There is still much uncertainty about growth of mixedwood and deciduous stands under silvicultural management, and managed stand yield tables for those stand types were not available for the analysis. Removal of coniferous-leading mixedwood stands from the timber harvesting land base left only pure coniferous stands. On average, the coniferous timber harvesting land base without mixedwood stands was therefore more productive than in the base case. Long-term deciduous timber supply decreased proportionately to the land base change since regenerated stands were assumed to grow at the same rate as existing naturally established stands.

These results demonstrate that both coniferous- and deciduous-leading mixedwood stands contribute substantially to the base case timber supply. Achievement of harvests indicated in the base case would therefore depend on continued utilization of timber from mixedwood stands.

6 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is a complicated endeavor that must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human life spans, which means that decisions we make today have not only short-term but also long-term effects. In such a context, we cannot be certain that all data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision–making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide safe bases for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are discussed. The results that are based on current forest management assumptions (shown in Figures 8 to 15) are referred to as the base case.

Unsalvaged losses to natural forces such as insects and fire are estimated to be 64 000 cubic metres per year (58 000 cubic metres per year of coniferous and 6000 cubic metres per year of deciduous) for the entire 250-year horizon, and have been subtracted from all harvest forecasts shown in this report.

6 Timber Supply Sensitivity Analyses

6.1 Alternative harvest flows over time

The base case harvest forecasts shown in Figure 8 were defined mostly by the long-term productivity of the timber harvesting land base. As discussed in Section 5.1, the short- and medium-term timber supplies in the base case forecasts are not at the maximum possible levels. Given the accumulation of growth over many years, alternative harvest forecasts with higher initial levels are possible. Figures 18 and 19 show some alternatives.

Criteria used when generating alternative harvest flows include maintaining a fairly constant growing stock level over the long term, and avoiding any large and abrupt timber supply shortfalls. The first criterion is an indicator of long-term sustainability, while avoiding excessive timber supply fluctuations provides for socio-economic stability and helps to maintain future options. In the alternative harvest flows shown in this section, timber supply never declines below base case levels for either the coniferous or deciduous land bases.

Figure 18 compares an alternative coniferous harvest forecast to the base case. The alternative flow shows that a level 6.25% higher than the coniferous base case can be maintained for 5 decades, if the harvest then declines to the base case level for the long term. The elevated coniferous harvest forecast in Figure 18 shows the maximum short- and medium–term timber supplies that are consistent with avoiding severe timber supply disruptions and meeting current integrated resource management* objectives. The results suggest that an increase in the coniferous base case harvest level of up to 6.25% can be maintained for the first five decades without creating a risk of future timber supply disruptions.

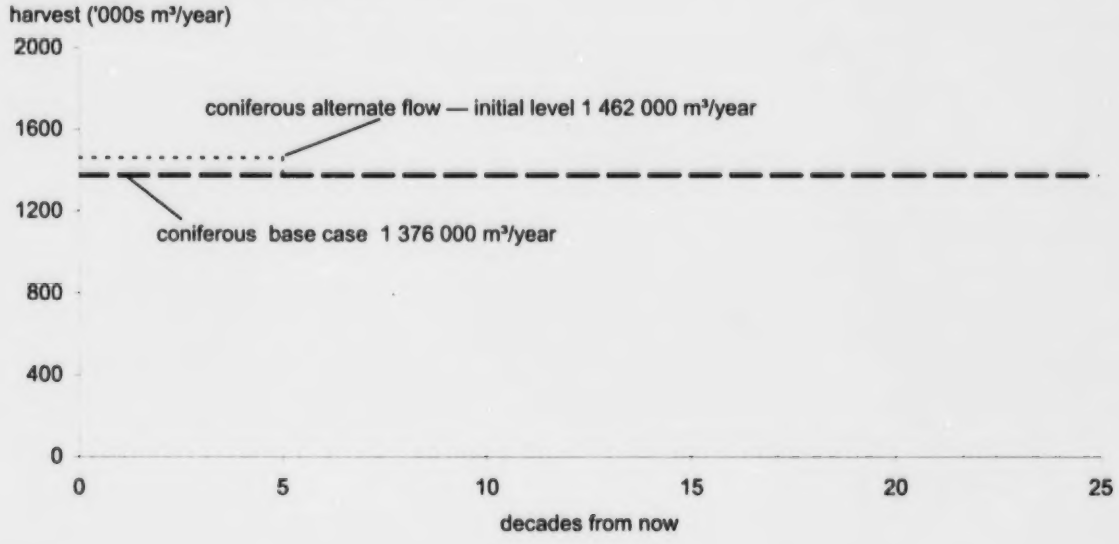


Figure 18. Alternative harvest forecast using base case data: coniferous land base — Fort Nelson TSA, 2000.

Integrated resource management
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

The alternative 1 harvest forecast shown in Figure 19 demonstrates that an initial deciduous harvest level 66% greater than the base case can be maintained for 5 decades, if followed by a 10% rate of decline to the long-term harvest level.

The alternative 1 harvest forecast shows that the initial deciduous harvest level could be significantly higher relative to the base case over the next few decades. However, as Figure 20 displays, the deciduous growing stock associated with this forecast declines more quickly relative to the base case, and would take many years beyond the 250 year analysis horizon to increase to base case levels. The greater depletion of growing stock could limit flexibility to respond to future changes in management practices or objectives, or new information.

Figure 19 illustrates a second alternative forecast for deciduous stands (alternative 2) intermediate between the base case and alternative 1. As shown in Figure 20, the deciduous merchantable growing stock would again decline more under alternative 2 than the base case, but less than for alternative 1.

These alternative harvest forecasts illustrate existing old stands can be harvested more rapidly in the short term than suggested in the base case, particularly on the deciduous land base, while still achieving the same long-term harvest levels, and avoiding future timber supply disruptions. Higher short- and medium-term harvests can be achieved because of the volumes accumulated after many years of growth. However, the higher harvest levels could also reduce flexibility to respond to uncertainties associated with changes in management objectives or information. As a final note, any harvest forecasts with timber supply levels below the base case would also be possible.

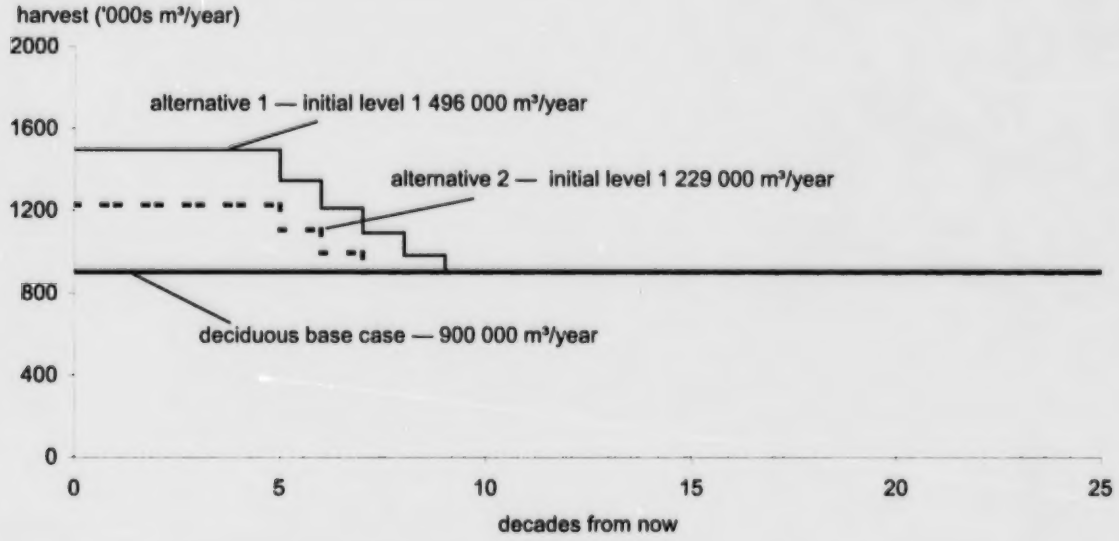


Figure 19. Alternative harvest forecasts using base case data: deciduous land base — Fort Nelson TSA, 2000.

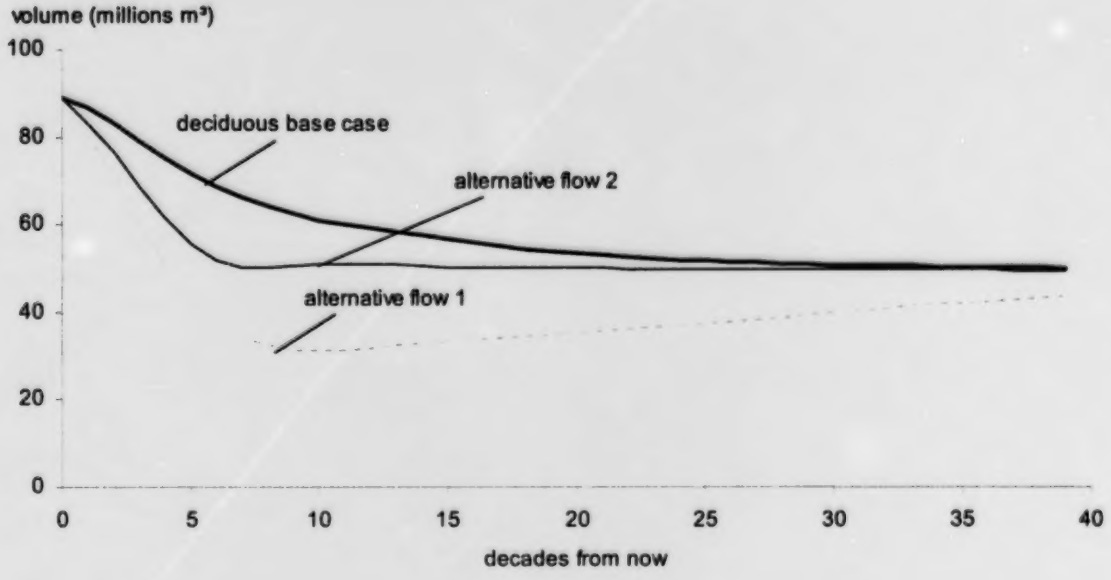


Figure 20. Deciduous growing stock for base case, alternative 1 and alternative 2 harvest forecasts — Fort Nelson TSA, 2000.

6.2 Uncertainty in approximations of adjacency guidelines

The *Forest Practices Code* requires that trees in a harvested area must reach a specified height (green-up height) before adjacent areas are harvested. To ensure that harvesting-related disturbance does not become overly concentrated in any area, a maximum limit was set on the overall area that has not reached the green-up condition. In this analysis, it was assumed that a maximum of 39% of the timber harvesting land base in each of the 72 landscape units could be covered by stands that have not met the 3-metre green-up height requirement. Forest cover requirements are used in the analysis as a proxy for adjacency guidelines. Some uncertainty surrounds the forest cover requirements because it is not possible to define the exact forest structure that would result from applying adjacency restrictions.

Analysis indicates that if adjacency requirements were not applied, neither the coniferous nor the deciduous harvest forecast depicted in the base case would be affected. These results suggest that the forest cover requirements applied in the base case used to approximate adjacency guidelines do not affect timber supply.

Likewise, the base case harvest forecast is not affected if green-up height is increased to 8 metres from the 3 metre height assumed in the base case. This change corresponds to an increase in the average age green-up age to 30 years from the base case average of 15 years. In fact, green-up ages could be extended beyond the time required to achieve 8 metres by another 6 years for coniferous stands, and 15 years for deciduous stands before significant deviations in timber supply would occur relative to the base case forecasts.

In the base case, adjacency is constraining in individual landscape units for short periods during of the 250-year horizon. The timber supply is not affected overall however, as harvesting is able to shift among landscape units and allow green-up requirements to be met while achieving overall harvest flow. The sensitivity analysis in which green-up heights are increased to 8 metres indicates further that uncertainty about green-up requirements associated with adjacency do not significantly affect the base case harvest forecast.

6.3 Uncertainty in forest cover requirements for visual quality objectives

The B.C. Forest Service, Forest Practices Branch, has provided a range of allowable visible disturbance for each visual quality class (VQC) (see Section 3, "Information Preparation for the Timber Supply Analysis", and Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis"). The period required to achieve visually effective green-up includes both the time to reach the green-up height and the regeneration delay*, or time taken to establish a stand after harvesting.

Uncertainty about forest cover objectives may arise from: inventory and classification of land into visual quality classes and sensitivity categories; estimates of how well different disturbance limits meet visual objectives; estimates of how non-harvestable forest may contribute to visual quality; variations in timing of stand establishment; and uncertainties about growth and yield, which may mean that stands will reach the desired condition sooner or later than estimated.

Only 11.8% of the coniferous, and 13.7% of the deciduous timber harvesting land bases are subject to VQOs. Of the total forested area with a visual sensitivity* rating (358 331 hectares), only 30% of the VQOs in the coniferous area and 36% in the deciduous area are on the timber harvesting land base. Therefore, forest excluded from the timber harvesting land base contributes significantly to meeting visual management objectives.

Potential harvest levels over both the short- and long-terms are not highly sensitive to uncertainty in green-up heights in visual management areas. Figure 21 shows that if green-up heights were 10 metres rather than the 5 metres used in the base case (corresponding to average ages of 33 years and 20 years respectively), timber supply for deciduous stands would be unchanged, while the projected coniferous harvest would be 30 000 cubic metres per year (2.2%) lower than in the base case.

Removing the visual quality objectives results in a coniferous harvest level of 1 385 000 cubic metres per year, approximately 0.7% higher than in the base case. There is no significant change in the deciduous harvest forecast relative to the base case, when the visual quality requirements are removed.

The lack of sensitivity in deciduous timber supply is due to the flexibility provided by the existing timber inventory, as evidenced by the potential for short- and medium-term timber supply increases shown in Figure 19 (Section 6.1, "Alternative harvest flows over time"). In the short- and medium-term, the growing stock provides a buffer against any further restriction in visual quality forest cover requirements. Conversely, there is not as much flexibility in coniferous timber supply (see Figure 18).

Neither coniferous nor deciduous timber supply are sensitive to changes in requirements for visual quality within the range tested, because forest outside of the timber harvesting land base plays a large role in achieving visual quality objectives, and because the area subject to VQOs is fairly small (12.6% of the timber harvesting land base). In addition, the flexibility afforded by existing deciduous growing stock provides an additional buffer to any increases in visual quality requirements.

Regeneration delay
The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

Visual sensitivity
A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.

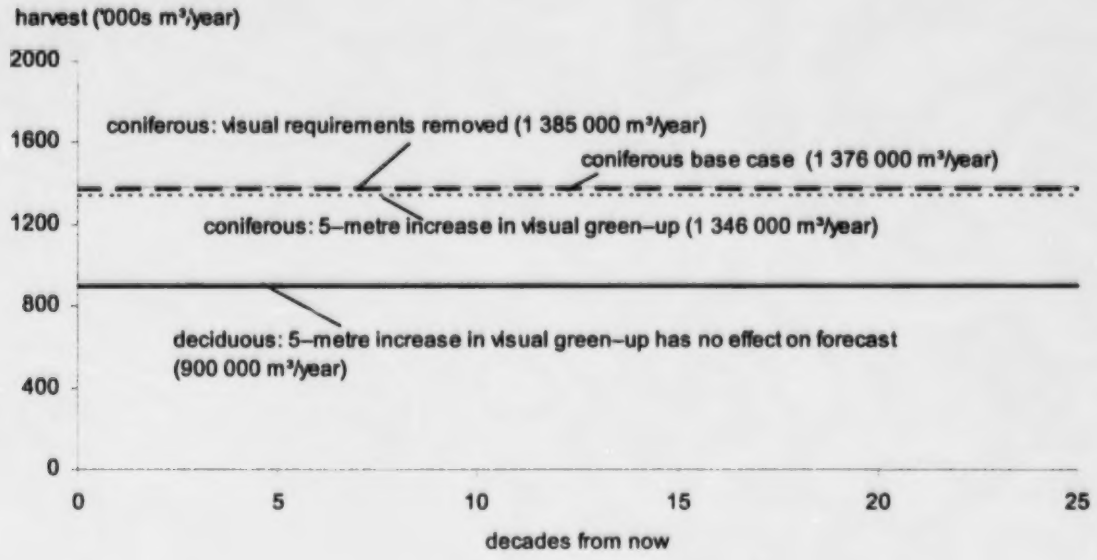


Figure 21. Harvest forecasts if green–up heights to meet visual objectives were 10 metres — Fort Nelson TSA, 2000.

6.4 Uncertainty in landscape-level biodiversity old forest requirements

The *Forest Practices Code Act of British Columbia* (FPC) describes the conservation of biological diversity as an essential component of sustainable use of forests. The FPC *Biodiversity Guidebook* provides recommendations for maintaining biodiversity at both the stand and the landscape levels. Stand-level biodiversity has been addressed in this analysis through removal of portions of each stand from the timber harvesting land base. Therefore, uncertainty about stand-level biodiversity can be assessed through sensitivity analysis that examines the timber supply impacts of changes in the size of the timber harvesting land base.

Management for landscape-level biodiversity was modelled in this analysis through the use of forest cover requirements applied to each combination of natural disturbance type, biogeoclimatic subzone and variant within each landscape unit. In the base case, requirements for old seral representation were applied in the Spruce-Willow-Birch (SWB) biogeoclimatic zone (NDT 2), while mature-plus-old and old seral requirements were applied in the Boreal White and Black Spruce (BWBS) zone (NDT 3), as described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." The old and mature-plus-old requirements were weighted according to the assumption that ultimately, lower and intermediate biodiversity emphases will both apply to 45% of the land base, while higher biodiversity emphasis will apply to 10%. No requirements limiting the area in early seral condition were applied in the base case.

While the approach used in the base case represents current policy for managing and analyzing landscape-level biodiversity, there is uncertainty about how the recommendations in the *Biodiversity Guidebook* will be interpreted and applied. For example, biodiversity emphasis options for each landscape unit have not been legally established. Several sensitivity analyses were performed to evaluate the potential timber supply impacts associated with uncertainty about landscape-level biodiversity management:

1) apply early- and mature-plus-old, as well as old-seral requirements in all NDT and biogeoclimatic variant combinations within each landscape unit, as outlined in Tables 7 and 11 of the *Biodiversity Guidebook*;

2) apply mature-plus-old as well as old seral requirements to the same NDTs as in the base case, but use requirements applicable to the biodiversity emphasis options developed for all landscape units as part of the Fort Nelson District landscape planning process (BEO assignments), rather than weighted requirements;

3) apply early-, mature-plus-old, and old seral requirements to the same NDTs and biogeoclimatic variant combinations as in the base case, but use requirements applicable to higher biodiversity emphasis in all landscape units, rather than weighted requirements.

In none of these cases is timber supply either increased or decreased. The lack of impact is due primarily to abundant existing mature and older stands in the timber harvesting land base that meet the requirements in the short- and medium-term while stands outside of the timber harvesting land base age enough to meet the requirements over time.

Retention of some mature and older forest within the timber harvesting land base is needed initially to achieve biodiversity requirements. In the base case, after 130 years, most of the mature- and old-seral requirements are met by stands outside the timber harvesting land base.

Even if the entire TSA were subject to higher biodiversity emphasis, the older stands in the timber harvesting land base are sufficient to meet the seral requirements until stands outside the timber harvesting land base have aged, and fully meet the requirements within 200 years. When the biodiversity requirements are changed, the order in which stands are harvested changes relative to the base case, some mature or older stands are reserved from harvest longer, and some of the younger regenerated stands are harvested earlier, but overall timber supply is not affected.

In summary, analysis results suggest that the timber supply of the Fort Nelson TSA is not sensitive to the application of early-, mature- and old-seral stage objectives outlined in the *Biodiversity Guidebook*, or to the application of more stringent landscape-level biodiversity emphasis requirements. Recent operational experience indicates that implementation of biodiversity requirements may be more challenging than suggested by the analysis results. The analysis methods do not account for factors such as spatial distribution, size, species composition of forest patches, and the pattern of existing disturbance that influence the ability to achieve seral-stage representation objectives. Future development of spatial analysis techniques and supporting data may improve the capability to examine spatial issues such as those mentioned, but at this time the information used in the analysis is the best available.

6.5 Uncertainty in the land base to which biodiversity requirements are applied

In the base case, forested areas excluded from the timber harvesting land base are forecast to meet almost all landscape biodiversity requirements for old-age forest, particularly over the long term. However, some uncertainty surrounds the application of the biodiversity requirements, since some of the old-age forests may be retained within the timber harvesting land base to meet habitat objectives. Figure 22 shows the implications to timber supply if requirements for old-age forests must be achieved on the timber harvesting land base, as well as on the total forested area.

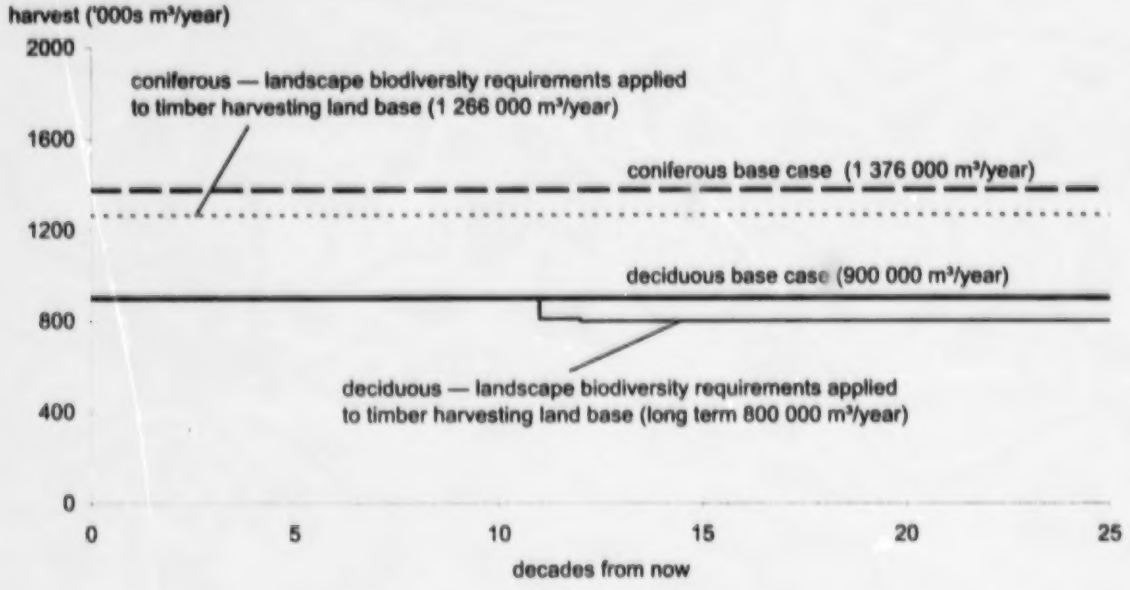


Figure 22. Harvest forecasts if requirements for old seral forests are applied to the timber harvesting land base — Fort Nelson TSA, 2000.

Applying forest cover requirements for old forest to the timber harvesting land base reduces the timber supply relative to the base case. The coniferous harvest forecast is 110 000 cubic metres (8%) lower than in the base case. Short- and medium-term deciduous timber supply is not affected, but the deciduous long-term harvest level is 100 000 cubic metres per year (11%) lower than the base case.

Removing older forest cover requirements would have little impact on timber supply because, in the base case, these requirements are largely met by stands outside the timber harvesting land base. Since the requirements do not constrain the base case harvest forecast, removing them would not provide any additional timber supply.

In summary, uncertainty in the area of application of old forest requirements could affect timber supply. Minimum requirements for old-seral forest on the timber harvesting land base, as well as on the total forest area, reduce coniferous timber supply over all time frames relative to the base case, but reduce only the long-term timber supply on the deciduous land base.

6.6 Uncertainty in minimum harvestable ages

Minimum harvestable age is an estimate of the time needed for a stand to reach a merchantable condition, and affects how quickly existing stands may be harvested. The time at which stands will become merchantable is highly uncertain because of uncertainty about the growth of regenerated stands, and an inability to foresee future conditions that will determine merchantability. In addition, the relatively short history of harvesting within the Fort Nelson TSA combined with an abundance of older forest means minimum harvestable ages have not been clearly demonstrated.

For this analysis, minimum harvestable ages were estimated as the age at which stands reached a minimum volume. These minimum stand volume criteria are described in detail in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis," and apply to both managed and unmanaged stands. This method was chosen to ensure that only stands with sufficient stem size and merchantable volume would be considered available for harvest. Stands may be harvested at older, but not younger ages than the minimum harvestable ages. In fact, many stands are harvested at ages beyond the minimum in order to meet management objectives such as forest cover requirements. Minimum harvestable ages are meant to approximate the timing of merchantability, and are not legal or policy requirements.

Currently, 78% of existing stands currently exceed the minimum harvestable ages which range from 45 to 114 years in the Fort Nelson TSA (Figure 3). Figure 13 indicates that the average harvest age in the base case is projected to exceed the minimum harvestable ages throughout the 250-year horizon.

It is not surprising, therefore, that increasing minimum harvestable ages by 20 years from the base case values does not affect the timber supply. Likewise, no additional timber supply would be gained over the base case if the minimum harvestable ages were decreased by 20 years. The lack of sensitivity to changes in minimum harvestable ages applies to short-, medium- and long-term timber supply. While overall timber supply is unaffected by 20-year changes in minimum harvestable ages, variation in the ages would affect the flexibility in choosing stands available for harvest during the transition to harvesting regenerated stands.

6.7 Uncertainty in estimates of timber volumes in existing stands

Estimates of standing timber volumes in existing forest stands are subject to some uncertainty because they are based on measurements from some stands extrapolated to all stands in an area, and on inventory classifications which contain some uncertainty. The standing volumes are normally accurate when averaged over large areas, but may not reflect actual volumes in a specific stand. Uncertainty may also stem from estimates of the volume lost to decay in standing trees, and to waste and breakage during timber harvesting, as well as estimates of utilization levels practiced during harvesting. For this analysis, the variable density yield prediction (VDYP) model was used to project growth of existing stands of all ages. Only coniferous stands harvested from now on were assumed to be managed stands for the projection of growth and yield (see Section A.4.7 of Appendix A).

The base case harvest forecasts for the Fort Nelson TSA are not highly sensitive to increases in existing stand volume estimates. If existing volumes were 10% greater than those used for the base case, neither the coniferous nor the deciduous harvest forecast would be affected, since the even-flow forecasts are limited mostly by the long-term productivity of the land base, not the availability of existing timber. The long-term harvest levels are unaffected by changes to existing stand volumes.

However, Figure 23 illustrates the effect on timber supply if short- and medium-term timber supply could be increased above the long-term harvest level. If existing stand volumes are 10% greater than in the base case, and an elevated harvest is permitted, a coniferous harvest of 1 814 000 cubic metres per year can be maintained for 5 decades before declining to the base case long-term level. A initial deciduous harvest of up to 1 596 000 cubic metres per year can be maintained for 5 decades before declining at 10% per decade to the base case long-term level. This deciduous forecast is comparable to alternative forecast 1 in Section 6.1, "Alternative harvest flows over time" in that it involves a more rapid decline in growing stock than under forecasts with lower short-term harvest levels.

In summary, if existing stand volumes have been underestimated, results indicate that harvest scheduling could benefit from greater flexibility over the short- and medium-terms, or the coniferous and deciduous harvest levels could be elevated from the base case in the short- and medium-term.

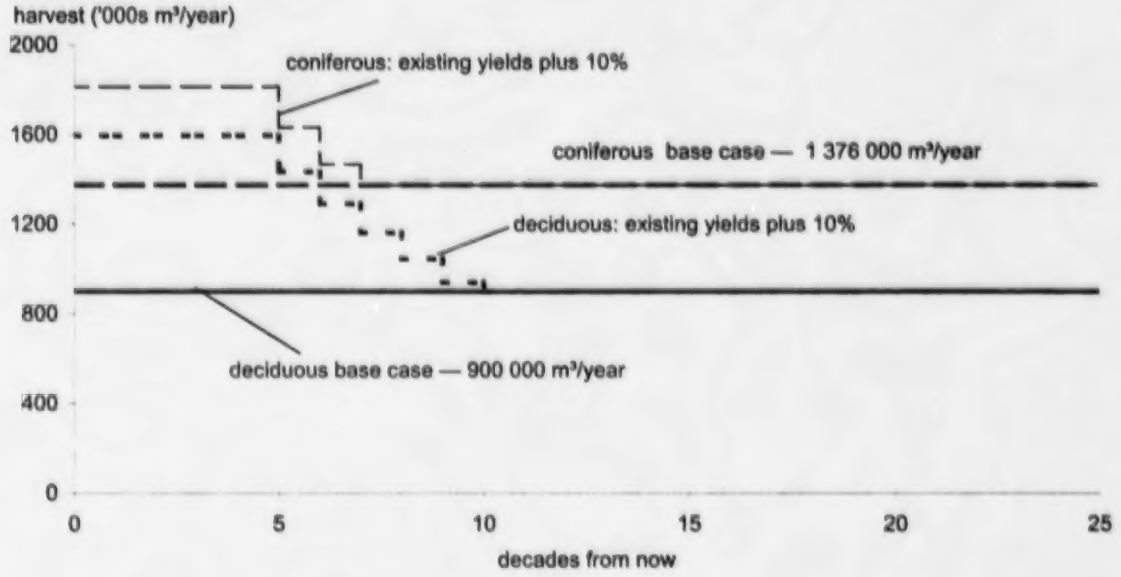


Figure 23. Elevated harvest forecast if existing stand volumes are increased by 10% — Fort Nelson TSA 2000.

Figure 24 illustrates the effect on Fort Nelson TSA timber supply of decreasing existing stand volume estimates by 10%. If existing volumes are overestimated by 10% in the base case, the initial coniferous harvest level would be 90 000 cubic metres (6.5%) lower than the base case, and timber supply would increase to the base case long-term level beginning 160 years from now. If existing volumes were 10% lower than estimated for the base case, the total coniferous harvest over the next 250 years would need to be about 4.2% less than in the base case to avoid creating severe timber supply disruptions further in the future. The deciduous base case forecast is not affected by a 10% decrease in existing stand volumes.

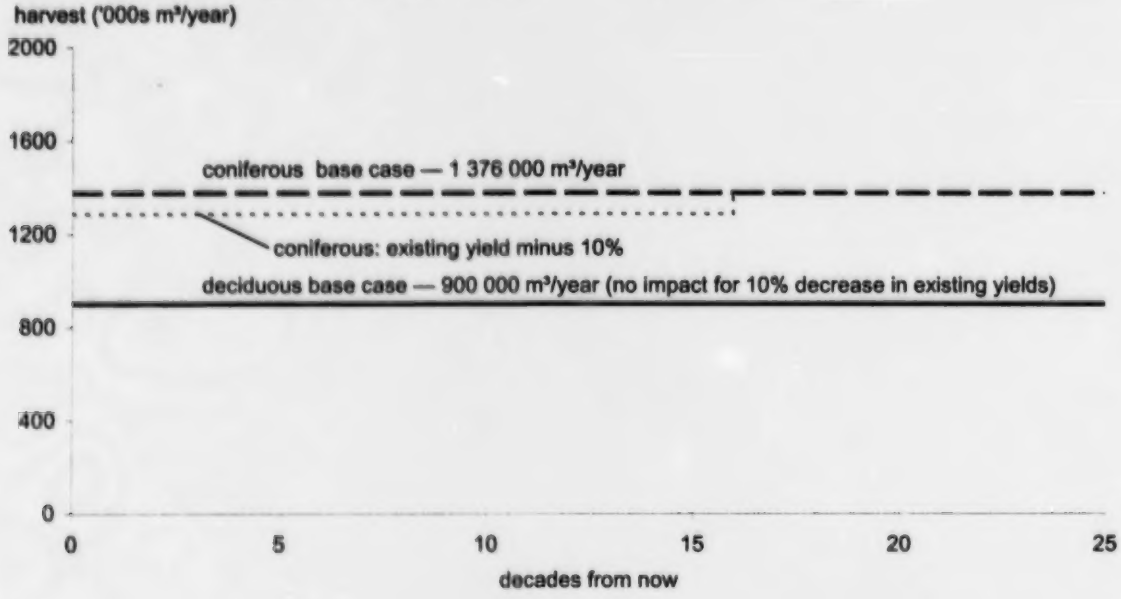


Figure 24. Effect on harvest forecast if existing stand volumes are decreased by 10% — Fort Nelson TSA 2000.

This sensitivity analysis shows that coniferous timber supply over the short- and medium-term is sensitive to reductions in estimates of standing volumes in existing mature forests. As the volume of timber that can be harvested from each stand decreases, more area must be harvested to obtain the same total harvest volume, or the total volume harvested must decrease to ensure a gradual transition to harvesting second-growth forest.

Currently, uncertainty about existing stand volumes is of some concern. Parts of the Fort Nelson TSA have not been re-inventoried since the early 1970's. The majority of the current inventory was classified from aerial photos that provided less detail than more modern aerial photography. To date, no inventory audits have been completed to indicate that the inventory is inaccurate. However, considering the age, methods and standards used to generate the current inventory, there are likely some inaccuracies that will be rectified with on-going and planned re-inventory projects. These comments are included to place the coniferous forecasts in particular, which are significantly above current allowable harvesting levels, into the context of current uncertainties about the forest inventory in some areas of the Fort Nelson TSA.

6.8 Uncertainty in regenerated stand volume estimates

Estimates of timber volumes in regenerated managed stands are uncertain for similar reasons as existing stand volumes, compounded by a relative lack of long-term experience and data about the growth of managed stands. In this section, the timber supply effects of uncertainty associated with predicting volumes in regenerated stands is examined.

Figure 25 shows the harvest forecasts that result if regenerated volumes are increased and decreased by 10% from those assumed in the base case. A coniferous long-term harvest level approximately 9% higher than in the base case could be obtained beginning about 160 years from now. The deciduous harvest forecast could increase immediately to a constant level of 993 000 cubic metres per year, 10.3% above the base case.

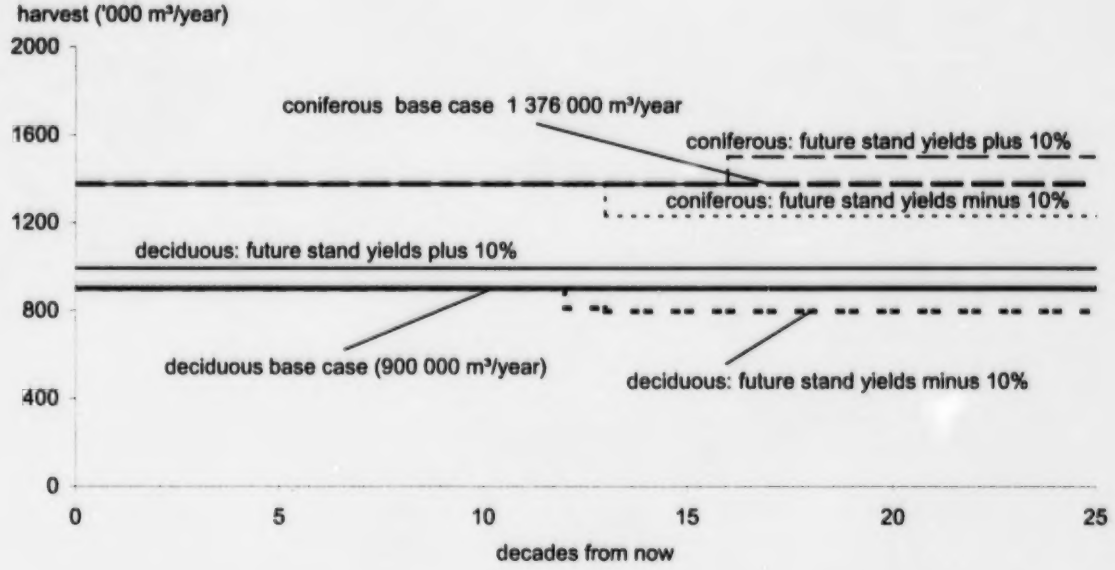


Figure 25. Harvest forecasts with regenerated stand volume estimates increased and decreased by 10%—Fort Nelson TSA, 2000.

The analysis indicates the initial coniferous base case timber supply can be achieved for 130 years, after which timber supply would decline to the long-term level 10% lower than in the base case. For deciduous stands, if regenerated stand volumes were 10% lower, the current deciduous AAC could still be maintained for 130 years before declining to a lower long-term harvest level of 797 000 cubic metres per year. In general therefore, if regenerated volumes were 10% lower than assumed in the base case, the long-term harvest levels would be about 10% lower, but base case timber supply could be maintained for over one hundred years.

In summary, the sensitivity of both coniferous and deciduous timber supply to uncertainty in regenerated stand volumes depends on the approach that is taken to harvest flow pattern, and to the direction of uncertainty. Coniferous supply over the short- and medium-terms is not sensitive to increases in regenerated stand volumes. If regenerated stand volumes are lower, the short- and medium-term timber supply shown in the coniferous base case can be achieved, but would require a future reduction to a lower long-term level. For deciduous species, timber supply over all time frames would increase in direct proportion to increases in regenerated stand volumes. Similar to the case for coniferous stands, short- and medium–term deciduous supply could be maintained if future stand volumes were lower, but eventually timber supply would need to decline to a lower long-term level. In all cases, long-term timber supply changes in approximate proportion to changes in regenerated stand volumes.

6.9 Uncertainty in land base available for harvesting

Defining the timber harvesting land base for this analysis involved setting minimum site productivity thresholds below which different forest types were excluded from the timber harvesting land base. Minimum stand volume and height, in conjunction with an assessment of past performance, were used to estimate the site productivity thresholds. Since approximations were used to define the land base, and because the inventory itself contains uncertainty, there is some uncertainty about how much area actually falls within the timber harvesting land base under current management.

To assess the impacts of this and other potential sources of uncertainty in defining the timber harvesting land base, site productivity thresholds were both increased and decreased based on the upper and lower bounds of uncertainty. The range of uncertainty considered for site productivity thresholds is discussed in Appendix A (Section A.3.7). Adjustments reflecting the site productivity thresholds were made for the subsequent land base deductions (for example, riparian areas, roads and stand-level biodiversity). In addition, changes in the size of the timber harvesting land base would result in corresponding changes to the forested area outside the timber harvesting land base that contributes to seral-stage requirements. Table 5 shows the site index thresholds used in the base case and for the sensitivity analyses.

Table 5. Site index thresholds (m @ 50 years) for defining the timber harvesting land base — Fort Nelson TSA, 2000

Leading species	Base case threshold	Increased land base (lower threshold)	Decreased land base (higher threshold)
Spruce	10.8	9.2	12.0
Lodgepole pine	16.4	13.7	18.4
Aspen	17.7	15.0	19.6
Cottonwood	14.0	11.4	16.8
Balsam	10.7	8.8	12.4

If the lower range of uncertainty for site productivity cut-offs were used, the timber harvesting land base would be 1 173 983 hectares (26.9% larger than the base case). The coniferous timber harvesting land base would be 686 709 hectares (31.4% larger), while the deciduous timber harvesting land base would be 487 274 hectares (21.2% larger). Conversely, if the upper bound of uncertainty for the site productivity cut-offs were used, the overall timber harvesting land base would be 699 019 hectares (24.4% smaller than the base case). The coniferous timber harvesting land base would be 433 230 hectares (17.1% smaller), while the deciduous timber harvesting land base would be 265 789 hectares (33.9% smaller). Figure 26 shows the timber supply results for the coniferous land base, and Figure 27 displays results for deciduous stands.

As shown in Figure 26, with an increased land base corresponding to the lower site productivity threshold, the coniferous harvest forecast would increase to 1 816 000 cubic metres per year, 32% above the base case. The increase in coniferous timber supply is approximately proportional to the land base change (31.4% larger). With the land base decreased by 17.1%, the coniferous harvest level would be 1 119 000 cubic metres per year, 18.7% lower than the base case long-term timber supply.

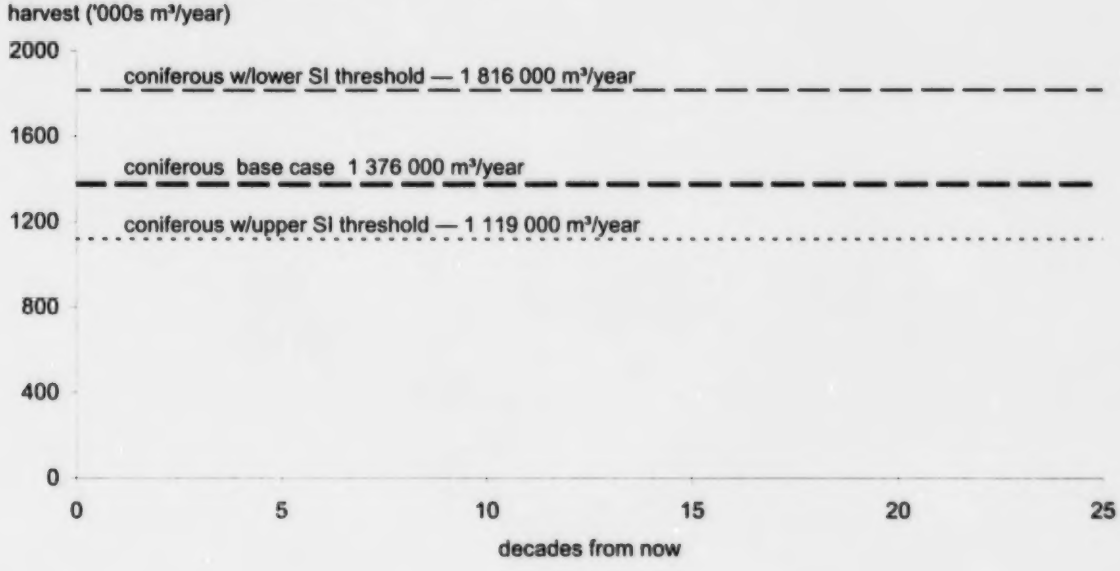


Figure 26. Coniferous harvest forecasts reflecting upper and lower site productivity thresholds — Fort Nelson TSA, 2000.

Figure 27 shows that the deciduous harvest forecast would increase to 1 091 000 cubic metres per year. This level is 21.2% above the base case, the same as the increase in the deciduous land base. Given a 33.9% reduction in land base corresponding to the upper site productivity threshold, the current deciduous AAC could be maintained for 40 years before declining to the long-term harvest level of 588 000 cubic metres, 34.7% lower than the base case long-term level.

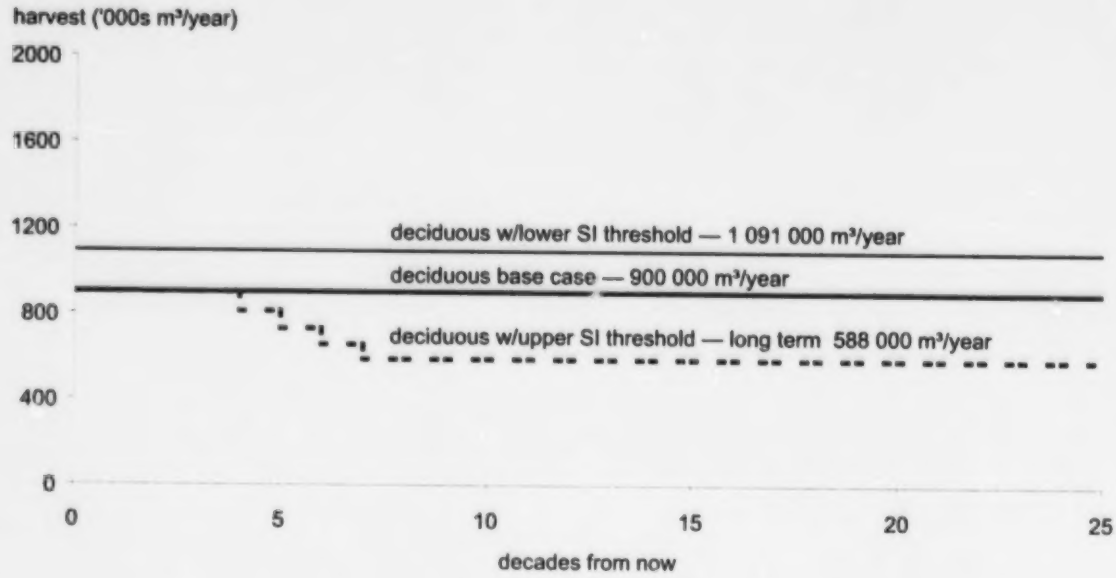


Figure 27. Deciduous harvest forecasts reflecting upper and lower site productivity thresholds — Fort Nelson TSA, 2000.

In summary, timber supply is sensitive to uncertainty about the size of the timber harvesting land base. Changes in the size of the timber harvesting land base affect how much the coniferous harvest level can be increased from its current level of 600 000 cubic metres per year. Similarly, increases in the size of the timber harvesting land base could permit the deciduous harvest level to be increased from the current AAC of 900 000 cubic metres per year. Conversely, the current deciduous AAC could be maintained for at least four more decades if the timber harvesting land base is over 30% smaller than estimated for the base case.

6.10 Combined uncertainty — mixedwood stands, site productivity threshold

Given the importance to the timber supply projections of both the contribution of mixedwood stands, and the site productivity thresholds used to define the timber harvesting land base, a sensitivity analysis was done to examine the interaction between these two variables. The implications for the timber harvesting land base of excluding mixedwood stands, and employing either the upper or lower end of the site productivity ranges are:

- coniferous:
  upper site index threshold — 47.5% reduction (to 274 319 hectares);
  lower site index threshold — 14.2% reduction (to 448 457 hectares).
- deciduous:
  upper site index threshold — 52.7% reduction (to 190 384 hectares);
  lower site index threshold — 17.3% reduction (to 332 651 hectares).

The variation in the land base demonstrates the potential for uncertainty in the site index thresholds either to increase or offset any timber supply reductions associated with exclusion of all or some of the mixedwood stands. Figures 28 and 29 show the changes to timber supply associated with the land base changes.

Exclusion of coniferous-leading mixedwood, together with use of the upper range of the site index thresholds resulted in a forecast of 855 000 cubic metres per year, 38% below the base case. Conversely, exclusion of coniferous-leading mixedwood, together with the lower site index thresholds led to a timber supply projection only 2% lower than the base case (1 347 000 cubic metres per year).

Exclusion of deciduous-leading mixedwood, together with the upper range of the site index thresholds resulted in a declining forecast with only one decade at the current deciduous allowable cut, and a long-term level almost 52% lower than in the base case. Exclusion of deciduous-leading mixedwood, together with the lower site index thresholds led a timber supply projection with 60 years at the current allowable cut, and a 22% reduction from the base case long-term level.

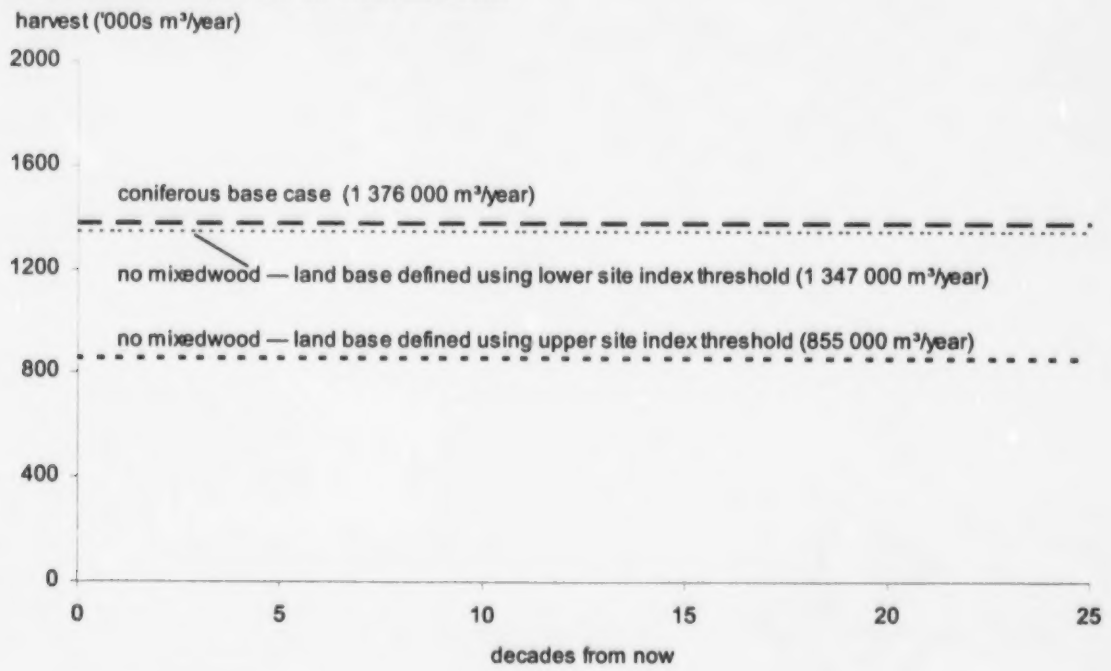


Figure 28. Coniferous harvest forecasts if mixedwood stands are removed from the timber harvesting land base and site productivity threshold changed — Fort Nelson TSA, 2000.

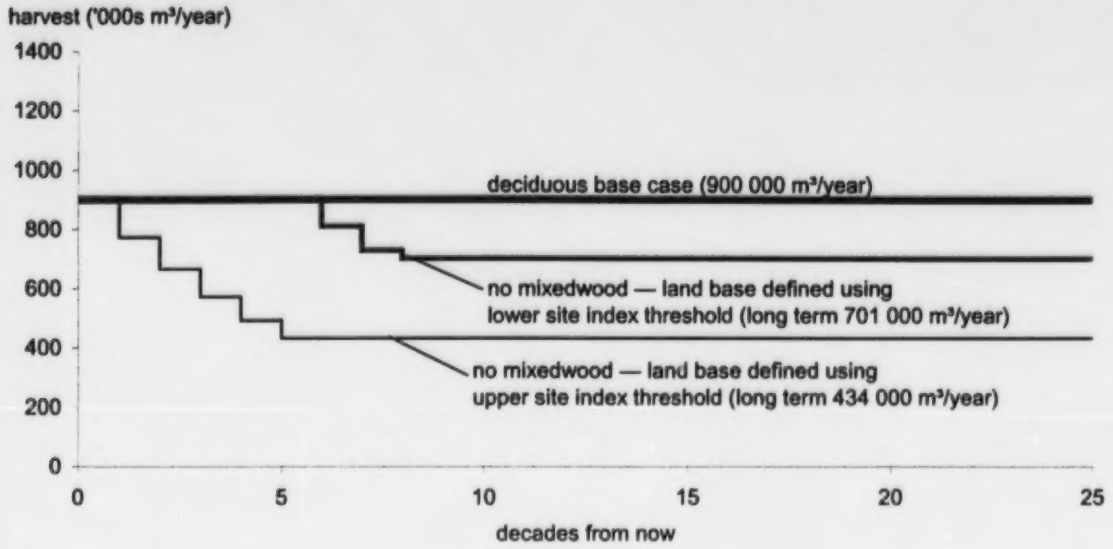


Figure 29. Deciduous harvest forecasts if mixedwood stands are removed from the timber harvesting land base and site productivity threshold changed — Fort Nelson TSA, 2000.

6.11 Uncertainty regarding establishment of new protected areas

A *Land and Resource Management Plan* (LRMP) was approved by Cabinet in October 1997. In June 1999, a total area of 842 271 hectares of protected areas proposed in the LRMP were officially designated by government. Only 750 945 hectares of the new parks are within the Fort Nelson TSA. It is anticipated that a further 79 872 hectares within the TSA will become Order-in-Council protected areas or ecological reserves. When the analysis was undertaken, the currently designated areas were still proposals, and the information available at that time was used for the sensitivity analysis. The proposals that were assessed, which closely reflect the ultimate designations, cover 1.9% of the total timber harvesting land base (2.1% of the coniferous, and 1.8% of the deciduous timber harvesting land bases). As Figure 30 indicates, the coniferous harvest forecast would be 29 000 cubic metres per year (2.1%) lower than the base case if the protected areas were excluded from the timber harvesting land base. The deciduous base case harvest level could still be maintained for several hundred years. Timber supply would need to decline by 16 000 cubic metres per year (1.8%) after about 350 years to stabilize the growing stock.

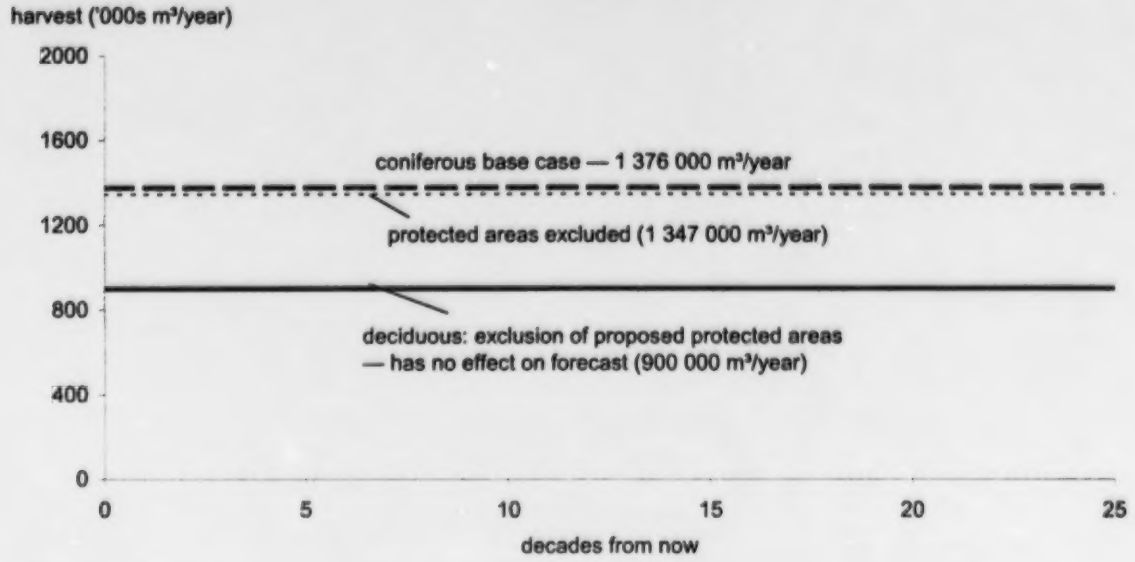


Figure 30. Harvest forecasts if proposed protected areas are not available for harvesting — Fort Nelson TSA, 2000.

In summary, analysis suggests that most of the parks recently designated in the Fort Nelson TSA fall outside the timber harvesting land base, and their exclusion has a very small impact on the base case timber supply forecasts.

6.12 Uncertainty in the harvest of cottonwood-leading stands

Recent market conditions have been unfavorable for the harvest and marketing of cottonwood, thus continued harvesting of cottonwood-leading stands is uncertain. Cottonwood-leading stands comprise 11.9% (about 48 000 hectares) of the deciduous timber harvesting land base.

Figure 31 indicates that if cottonwood-leading stands do not contribute to timber supply, the base case deciduous harvest level could be maintained for 130 years before declining by 99 000 cubic metres per year (11%). The base case deciduous timber supply level can be maintained for several decades because of the flexibility provided by an abundance of mature deciduous timber that, using base case data, allows for increases in timber supply over the first several decades of the forecast (see Section 6.1, "Alternative harvest flows over time").

Coniferous timber supply would not be affected by removal of cottonwood-leading stands from the timber harvesting land base.

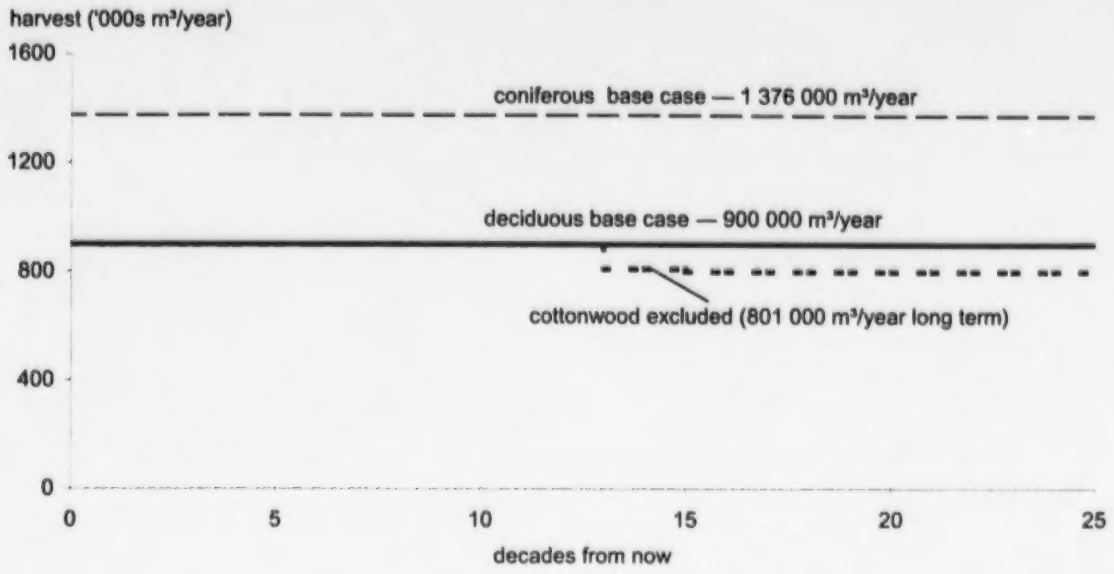


Figure 31. Harvest forecasts if cottonwood-leading stands are excluded from the timber harvesting land base — Fort Nelson TSA, 2000.

6.13 Uncertainty about utilization of birch-leading stands

Interest has been expressed in the harvest, processing and marketing of birch. A preliminary assessment indicates that birch-leading stands with a site index greater than 17 (metres at 50 years) could be marketable. The inventory indicates a total forested area of 167 517 hectares of birch-leading stands within the Fort Nelson TSA. If birch-leading stands with a site index greater than 17 metres are available for harvest, the timber harvesting land base would increase by 29 633 hectares (increases of 7.4% in the deciduous, and 3.2% in the total timber harvesting land bases).

Figure 32 shows that including birch-leading stands would permit the harvest of 55 000 cubic metres per year of birch-leading stands over the forecast horizon, if market conditions remain favorable. This volume would increase the deciduous timber supply by 6.1% over the base case. The harvest forecasts for coniferous and other deciduous species are not affected by the harvest of these birch-leading stands.

Fort Nelson Forest District staff have noted inconsistencies between the forest inventory and ground samples regarding the location of birch stands. Therefore, there is some uncertainty about the actual area of birch stands that would meet merchantability criteria. Due to the age of the inventory, the short-lived, early seral nature of birch and the quality of birch desired by processing facilities, the actual amount of merchantable birch on the land base is uncertain. Furthermore, it is possible that stand species composition may have changed since originally classified in the inventory. Further, classification of birch may not have been given the high level of attention that was accorded species considered merchantable when the inventories were originally compiled. Therefore, the timber supply indicated in this sensitivity analysis for birch-leading stands is highly uncertain, and should be interpreted with caution.

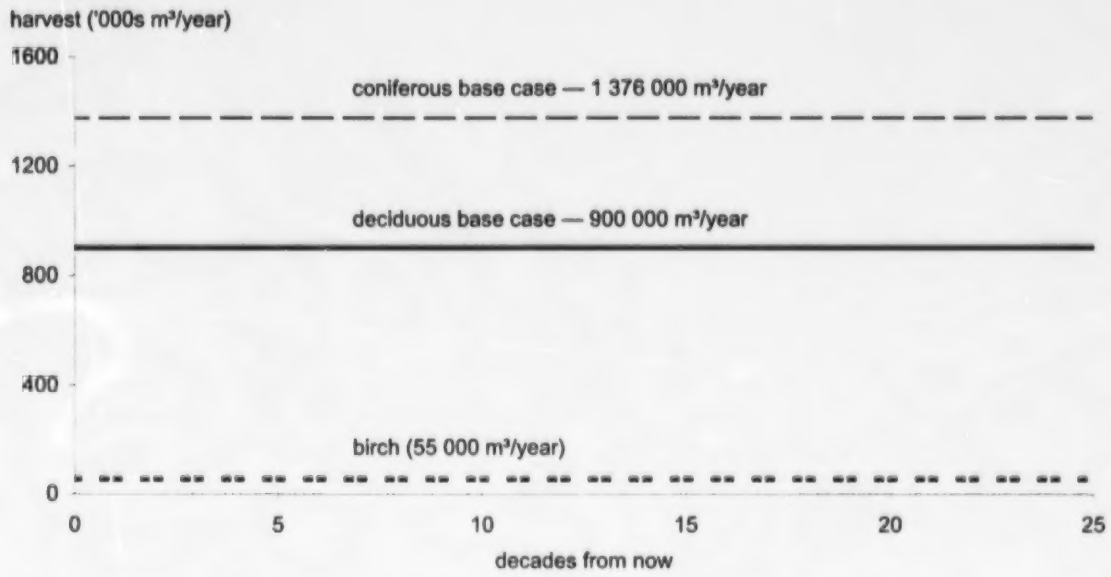


Figure 32. Harvest forecast from birch-leading stands — Fort Nelson TSA, 2000.

6.14 Summary of sensitivity analysis

Tables 6a and 6b summarize the results of the sensitivity analyses for coniferous and deciduous timber supply, respectively. The summary tables list the differences in average projected timber supply between each sensitivity analysis and the base case over both the next 100 years and between 101 and 250 years from now. These figures provide a quantitative basis for comparing the effects of various inventory and management uncertainties.

Differences between the base case harvest forecasts and the sensitivity analysis results over the short term (next 20 years) are not provided for most cases. In most sensitivity analyses, the resulting forecasts were even-flows, which means impacts are equal over all time frames. Where analysis showed that timber supply impacts could be different over the next 20 years than over the next 100 years, 20-year impacts are listed.

The figures provided in Tables 6a and 6b are based on the specific harvest patterns over time shown in this report. If different harvest patterns were followed, the changes relative to the base case could be slightly different. However, the results shown provide a general indication of both the overall magnitude, as well as the relative effects of different uncertainties.

Table 6a. Comparison of average timber supply over short-medium term (1-100 years) and long term (100-250 years), coniferous land base — Fort Nelson TSA, 2000.

Variable/Issue	Per cent difference from coniferous base case over years 1-100	Per cent difference from coniferous base case over years 100-250
Base case		
Coniferous 1 376 000 m³/year	—	—
Elevated harvest flows		
Alternative 1	+3.1% (+6.3% over years 1-20)	No change
Forest cover requirements to approximate adjacency (maximum 39% less than 3-metres in base case):		
Increase green-up height to 8 metres	No change	No change
Visual quality objectives		
(cover 12% of coniferous timber harvesting land base[a]): none	+ 0.7%	+ 0.7%
Visual green-up at 10 metres (versus 5 metres in base case)	– 2.2%	– 2.2%
Landscape biodiversity		
Apply early and mature requirements	No change	No change
All landscape units at low emphasis	No change	No change
All landscape units at high emphasis	No change	No change
No biodiversity requirements	No change	No change
Apply requirements to timber harvesting land base	– 8.0%	– 8.0%
Minimum harvestable ages		
Plus 20 years	No change	No change
Minus 20 years	No change	No change
Existing stand volumes		
Plus 10%	+ 18.5% (+ 31.8% over years 1-20)	No change
Minus 10%	– 6.5%	– 2.6% (– 0.7% over years 160-250)
Regenerated stand volumes		
Plus 10%	No change	+ 5.4% (+ 8.1% over years 160-250)
Minus 10%	No change	– 8.4% (– 10.5% over years 160-250)

(a) All percentage changes in area refer to the coniferous timber harvesting land base.

(continued)

Table 6a. Comparison of average timber supply over short-medium term (1-100 years) and long term (100-250 years), coniferous land base — Fort Nelson TSA, 2000 (concluded)

Variable/issue	Per cent difference from coniferous base case over years 1-100	Per cent difference from coniferous base case over years 100-250
Site index thresholds		
Upper end of range (17.1% decrease in timber harvesting land base)	– 18.7%	– 18.7%
Lower end of range (31.4% increase in timber harvesting land base)	+ 32.0%	+ 32.0%
New parks excluded (2.1% decrease in timber harvesting land base)	– 2.1%	– 2.1%
Cottonwood-leading stands excluded	No change	No change
Birch stands included	No change	No change
Black spruce stands included (47.6% increase in timber harvesting land base)	+ 30.5%	+ 32.3%
Mixedwood stands excluded (35.1% decrease in timber harvesting land base)	– 27.5%	– 27.5%
Mixedwood stands excluded, land base defined using upper site index threshold (47.5% decrease in timber harvesting land base)	– 37.9%	–37.9%
Mixedwood stands excluded, land base defined using lower site index threshold (14.2% decrease in timber harvesting land base)	– 2.1%	– 2.1%

Table 6b. Comparison of total volume harvested over short-medium term (1-100 years) and long term (100-250 years), deciduous land base — Fort Nelson TSA, 2000

Variable/issue	Per cent difference from coniferous base case over years 1-100	Per cent difference from coniferous base case over years 100-250
Base case		
Deciduous 900 000 m³/year	—	—
Elevated harvest flows		
Alternative 1	+ 21.7% (+ 36.6% over years 1-20)	No change
Alternative 2	44.6% (+ 66.2% over years 1-20)	No change
Forest cover requirements to approximate adjacency (maximum 39% less than 3-metres in base case):		
Increase green-up height to 8 metres	No change	No change
Visual quality objectives (cover 13.7% of deciduous timber harvesting land base[a]):		
None	No change	No change
Visual green-up at 10 metres (versus 5 metres in base case)	No change	No change
Landscape biodiversity		
Apply early and mature requirements	No change	No change
All landscape units at low emphasis	No change	No change
All landscape units at high emphasis	No change	No change
No biodiversity requirements	No change	No change
Apply requirements to timber harvesting land base	No change	– 10.3%
Minimum harvestable ages		
Plus 20 years	No change	No change
Minus 20 years	No change	No change
Existing stand volumes		
Plus 10%		
Even-flow	No change	No change
Elevated flow 1	+ 34.9% (+ 54.3% over years 1-20)	No change
Elevated flow 2	+ 54.0% (77.3% over years 1-20)	No change
Minus 10%	No change	No change

(a) All percentage changes in area refer to the deciduous timber harvesting land base.

(continued)

Table 6b. Comparison of total volume harvested over short-medium term (1-100 years) and long term (100-250 years), deciduous land base — Fort Nelson TSA, 2000 (concluded)

Variable/issue	Per cent difference from coniferous base case over years 1-100	Per cent difference from coniferous base case over years 100-250
Regenerated stand volumes		
Plus 10%	+ 10.3	+ 10.3%
Minus 10%	No change	– 9.8% (– 11.4% over years 160-250)
Site index thresholds		
Upper end of range (33.9% decrease in timber harvesting land base)	– 16.0%	– 34.7%
Lower end of range (21.2% increase in timber harvesting land base)	+ 21.2%	+ 21.2%
New parks excluded (1.8% decrease in timber harvesting land base)	No change	No change
Cottonwood-leading stands excluded (11.9% decrease in timber harvesting land base)	No change	– 8.7% (– 11% over years 160-250)
Birch stands included (7.4% increase in timber harvesting land base)	+ 6.1%	+ 6.1%
Black spruce stands included	No change	No change
Mixedwood stands excluded (31.6% decrease in timber harvesting land base)	– 18.9%	– 33.2%
Mixedwood stands excluded, land base defined using upper site index threshold (52.7% decrease in timber harvesting land base)	– 38.0% (– 7% over years 1-20)	– 51.8%
Mixedwood stands excluded, land base defined using lower site index threshold (17.3% decrease in timber harvesting land base)	– 7.3%	– 22.1%

7 Summary and Conclusions of the Timber Supply Analysis

Timber supply was assessed separately for areas of the Fort Nelson TSA with coniferous-leading and deciduous-leading stands. The results suggest that based on current forest practices, an annual harvest of 1 376 000 cubic metres, can be maintained from coniferous-leading stands over the long term. This timber supply level is 2.3 times greater than the current allowable annual cut for coniferous stands of 600 000 cubic metres. Results also indicate that deciduous-leading stands can support a non-declining annual harvest of 900 000 cubic metres, the current deciduous allowable annual harvest. Both the coniferous and deciduous timber supply forecasts are even-flows; that is, projections of constant supply over the 250-year analysis horizon.

The timber supply analysis examined the implications of two critical uncertainties: the potential contribution of black-spruce stands, which were not included in the base case timber harvesting land base; and the contribution of both coniferous- and deciduous–leading mixedwood stands, which were included in the base case timber harvesting land base.

Black spruce-leading stands were not included in the base case due to uncertainties about the inventory and the limited harvesting in stands dominated by black spruce. Inclusion of all operable black spruce stands above the specified site index thresholds increased the timber harvesting land base by 48% and increased timber supply by 30.5% over the next 100 years relative to the base case projection. Clearly, the potential timber supply contribution of black spruce in the Fort Nelson TSA may be large. However, a reduction in inventory — and silviculture-related uncertainties — including differentiation between merchantable and unmerchantable black spruce stands, and better understanding of regeneration difficulties associated with high water tables — will be required to provide more clarity on this potential contribution.

Mixed coniferous-deciduous stands comprise 35% of the coniferous timber harvesting land base. Excluding these mixedwood stands would decrease timber supply by 27.5% over the next 250 years. Mixed deciduous-coniferous stands comprise almost 32% of the deciduous timber harvesting land base. Excluding deciduous-leading mixedwood stands would decrease timber supply by 19% over the next 100 years, and 33% over the long term. However, the analysis suggests the current deciduous allowable cut could still be achieved for 30 years, while allowing for a gradual decline to the long-term level. Ministry of Forests staff from the Fort Nelson district and Prince George region are currently working with the local forest industry to develop a mixedwood management strategy for both coniferous- and deciduous-leading mixedwood stands.

An examination of potential alternative harvest forecasts to the even-flow base cases showed that for coniferous stands, an increase of 6.3% above the base case level of 1 376 000 cubic metres per year could be achieved for 50 years before a reduction to the base case was required. For deciduous stands, the analysis showed the potential for substantial increases (averaging 45%) above the base case harvest level over the next 100 years. The abundant deciduous inventory relative to the current deciduous allowable harvest can provide a buffer against uncertainties that affect timber supply.

Sensitivity analysis indicated that uncertainties about inventory, management and growth and yield could affect timber supply as indicated in the above base cases to varying degrees.

The uncertainty with the largest effect, other than the critical issues discussed above, is associated with site index thresholds used to exclude stands of low productivity from the timber harvesting land base. The site index thresholds were developed from a review of recent harvesting operations; nevertheless, they are still uncertain and subject to shifts in costs and market prices. The even-flow coniferous timber supply forecast could vary from 19% less to 32% more than the base case depending on whether the upper or lower end of a range representing uncertainty in site index thresholds were used. For deciduous stands, timber supply could increase to 21% above the base case if the lower end of the site index threshold were assumed. Based on the upper end of the threshold, the current deciduous allowable cut could be maintained, but a declining harvest forecast would be required, and long-term timber supply would be 35% lower than the harvest level projected in the base case.

7 Summary and Conclusions of the Timber Supply Analysis

The interaction between uncertainty about both the contribution of mixedwood stands and the appropriate site index thresholds could also have large effects on timber supply. Exclusion of coniferous-leading mixedwood stands, together with the upper range of the site index thresholds resulted in a forecast 38% below the base case. Conversely, exclusion of coniferous-leading mixedwood, together with the lower site index thresholds led to a timber supply projection only 2% lower than the base case. On the deciduous-leading land base, exclusion of mixedwood, together with the upper range of the site index thresholds resulted in a declining forecast with only one decade at the current deciduous allowable cut, and a long-term level almost 52% lower than in the base case. Exclusion of deciduous-leading mixedwood stands, together with the lower site index thresholds led to a timber supply projection with 60 years at the current allowable cut, and a 22% reduction from the base case long-term level. The results demonstrate that uncertainty in the site index thresholds either exacerbates or offsets any timber supply reductions associated with exclusion of all or some of the mixedwood stands from the timber harvesting land base.

Uncertainties with moderate effects on timber supply include: volume estimates for existing stands, volume estimates for regenerated stands, and the land base to which landscape-level biodiversity seral-stage requirements apply. For the deciduous land base, cottonwood- and birch-leading stands contribute moderately to timber supply.

At this time, there is no evidence specific to the Fort Nelson TSA to suggest that estimates used in the analysis for existing or regenerated stands are inaccurate. Any new information on growth and yield collected or derived as part of ongoing provincial programs can be used in future analyses.

Current provincial policy on landscape-level biodiversity, which is reflected in the base case, specifies that objectives should be achieved as much as possible in forest outside of the timber harvesting land base. Given the contribution of forest outside the timber harvesting land base to the landscape-level biodiversity guidelines, the analysis suggested that even application of early, mature-plus-old and old seral requirements corresponding to higher biodiversity emphasis in all draft landscape units would not affect the harvest forecasts. This lack of effect is due to the abundance of forest outside the timber harvesting land base in most landscape unit, biogeoclimatic variant combinations. Conversely, if the requirements needed to be achieved on the timber harvesting land base, as well as on the entire forest area, the coniferous timber supply would drop by 8% compared to the base case forecast. Deciduous timber supply in the short- and medium-terms would be unaffected, while long-term timber supply would drop by 10% compared to the base case.

Cottonwood stands make up 12% of the deciduous timber harvesting land base. While these stands are currently considered harvestable, their merchantability is highly variable. If cottonwood-leading stands were excluded from the timber harvesting land base, the deciduous base case could be maintained for 13 decades, after which projected long-term timber supply would decline to 11% below the base case. The abundance of deciduous growing stock relative to the current allowable cut provides a buffer against the decline in available inventory due to exclusion of cottonwood.

Birch-leading stands were not part of the base case timber harvesting land base. The current inventory suggests that the addition of birch stands would increase the deciduous timber harvesting land base by 7.4%, and provide an additional 55 000 cubic metres over the forecast horizon, an increase in the deciduous supply of 6%.

Uncertainties and issues with small to negligible effects on coniferous and deciduous timber supply include: visual quality management, forest cover requirements used to approximate the effects of cutblock adjacency guidelines, exclusion of recently designated protected areas from the timber harvesting land base, and minimum harvestable ages. Visual quality objectives apply to only 12% of the coniferous and 14% of the deciduous timber harvesting land base, and forest outside the harvesting land base meets most of the visual objectives.

7 Summary and Conclusions of the Timber Supply Analysis

In 1997, government approved a *Land and Resource Management Plan* (LRMP) for the Fort Nelson area. In June 1999, a total area of 842 271 hectares of protected areas identified in the LRMP were officially designated under the *Park Act*, of which 750 945 hectares are within the Fort Nelson TSA. When the analysis was undertaken, the areas were not designated, and the information available at that time was used for the sensitivity analysis. Exclusion of these areas, which closely approximate the final designation, reduced the coniferous harvest forecast by 2%, consistent with the contribution of the proposed areas to the timber harvesting land base. The deciduous harvest forecast was not affected over the 250-year analysis horizon, because the abundance of growing stock absorbed the inventory reduction associated with the land base exclusion. However, over the very long term (beyond the 250-year analysis horizon), timber supply would need to decline by 2% to correspond with the slightly smaller land base.

Changing minimum harvestable ages did not affect timber supply primarily because of the use of an even harvest flow defined the transition between existing and regenerated stands more so than harvestable ages. Forest cover requirements to approximate the effects of cutblock adjacency guidelines did not affect timber supply because of the flexibility to move among different areas of the TSA.

As a final note on coniferous timber supply, in none of the sensitivity analyses was timber supply reduced to the current coniferous allowable annual cut (600 000 cubic metres). Downward influences on the base case timber supply would need to combine to 56% to result in a harvest level below to the current allowable cut.

About 1.5 million hectares, currently part of the Cassiar TSA, will soon be added to the Fort Nelson TSA. This area is remote and not expected to contribute to Fort Nelson TSA timber supply over the next several years. Even over the longer term, it is not anticipated that the additional area will provide significant timber supply to the Fort Nelson TSA; however, it will contribute other resource values. The contribution of the additional area and its impact on the Fort Nelson TSA timber supply, if any, will be examined in the next timber supply review.

8 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. The socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Fort Nelson TSA to the level of activity that the TSA could support as the timber supply moves towards its long-term harvest level.

The socio-economic analysis examines harvest levels as projected in the base case harvest forecast and is not intended to examine alternative management scenarios.

The socio-economic analysis consists of the following:

1) a profile of the current socio-economic setting;
2) a description of the Fort Nelson TSA forest industry; and,
3) an analysis of the socio-economic implications of the base case harvest forecast.

8.1 Current socio-economic setting

8.1.1 Current population and demographic trends

Communities in the Fort Nelson TSA include Fort Nelson and smaller unincorporated areas, such as Prophet River, Toad River, and Muncho Lake. According to the 1996 Census, the population of the Northern Rockies Regional District[1] was 6,127, reflecting an increase of 18.0% from the 1991 level of 5,192. The population of the municipality of Fort Nelson increased by 17.5% between 1991 and 1996, to 4,612 from 3,924. Estimated 1999 population levels in the Northern Rockies Regional District and the municipality of Fort Nelson are 6,465 and 4,777 people, respectively.[2]

Fort Nelson's population growth can be attributed in part to increases in oil and gas development and exploration, the opening of the Canadian Chopstick Manufacturing Company (CCMC) plant, Slocan Forest Products Ltd. oriented strand board (OSB) plant, and an increase in the volume of timber harvested from the TSA. The chopstick plant suspended operations in April 1997 putting 180 individuals out of work.

From 1999 to 2001, the population of the Northern Rockies Regional District is forecast to grow by just over 3.5% to approximately 6,691.[3]

Table 7. Fort Nelson TSA and selected community population statistics, 1991-2001

	1991	1996	1999	2001	% change 1991-1996	% change 1996-1999
Fort Nelson	3,924	4,612	4,777	N/A	17.5	3.6
Rural areas and smaller communities	1,268	1,515	1,679	N/A	19.5	10.8
Northern Rockies Regional District	5,192	6,127	6,465	6,691	18.0	5.5
British Columbia	3,373,399	3,882,043	4,045,661	4,165,396	15.1	4.2

Source: Census of Canada 1991, 1996, includes net Census undercount. 1999 population estimates and 2001 projections from BC Stats Population Section. N/A = not available.

1. The Northern Rockies Regional District (formerly the Fort Nelson – Liard Regional District) includes the communities of Coal River and Fireside making it slightly larger that the Fort Nelson timber supply area.
2. BC Stats, Population Section. B.C. Ministry of Finance and Corporate Relations.
3. BC Stats, Population Section.

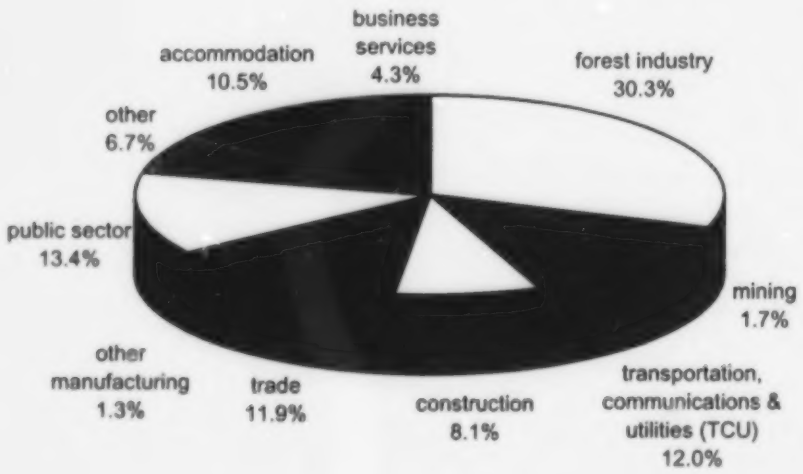
First Nations

The Fort Nelson TSA is covered by Treaty 8. The signatories to the Treaty in the TSA are the Fort Nelson First Nation, the Dene Tsaa Tse K'Nai First Nation (from Prophet River), and the Dena Tha' First Nation (from Assumption, Alberta). In addition, the Kaska-Dena First Nations have traditional territory in the TSA. The Fort Nelson First Nation has a total on and off reserve population of 651 and the Dene Tsaa Tse K'Nai First Nation (from Prophet River) has a total on and off reserve population of 173.[4] Since the population centres and reserves for both the Dena Tha' First Nation and the Kaska-Dena First Nation are located outside the Fort Nelson TSA, their population figures are not included here.

8.1.2 Economic profile

From 1991 to 1996, the total labour force in the Fort Nelson TSA grew by 24% to 3,385 from 2,730; this was the largest percentage increase of any TSA in the province.[5] In 1996, the unemployment rate in the Fort Nelson TSA and the broader Northern Development Region was 7.4%.[6] By 1998, the average unemployment rate in the Northeast Development Region declined to 4.0%, which was the lowest unemployment rate of province's eight development regions. However, the average 1999 unemployment rate (January to October) increased to 8.5%.

Figure 33 shows the experienced labour force by industry sector. The forestry sector, which consists of logging, forestry services, and forest products manufacturing is the largest industrial sector in terms of employment in the TSA accounting for approximately 30% of the total experienced labour force. From 1991 to 1996, total direct employment in the forestry sector increased from approximately 550 to 1,000; however, these figures do not reflect the shutdown of the Canadian Chopstick Manufacturing Co. Ltd. (CCMC) plant, which suspended operations in April, 1997, or the full employment level at Slocan Forest Products oriented strand board (OSB) mill, which commenced operations in 1996.



Source: 1996 Census of Canada.
Notes: Business services consist of finance, insurance, real estate and other business services; TCU consists of transportation, communications, and utilities. Other consists of personal services.

Figure 33. Experienced labour force by sector, Fort Nelson Forest District, 1996.

4. BC Registered Indian Population, Department of Indian and Northern Affairs, Government of Canada. December 1998.
5. Census of Canada 1991, 1996.
6. The Northeast Development Region is comprised of the Fort Nelson Forest District, and the Dawson Creek, Fort St. John, and part of the Mackenzie Forest Districts.

The service sector, which includes business services (finance, insurance, real estate, and other business services), transportation, communications and utilities (TCU), wholesale and retail trade, construction, and accommodation employed 54% of the total experienced labour force and indicates the central role of Fort Nelson in the provision of services to the region. Employment in many of the service sectors also increased substantially from 1991 to 1996. Employment in business services increased by 40%, construction employment increased by 77%, and employment in other personal services increased by 57%. Much of this service sector employment is supported by other sectors such as forestry, oil and gas, and the public sector through the purchase of supplies and services. Growth in these sectors since 1996 has likely slowed as indicated by the much slower population growth rates.

The oil and gas sector is the second largest industrial sector in the region. In Figure 33, it is included within the mining, other manufacturing, and TCU sectors and accounts for approximately 2% to 4% of the total experienced labour force. The oil and gas sector's TSA activity includes the Westcoast Energy natural gas processing plant, and ongoing exploration and development of new reserves. This sector also contributes indirectly to the forest industry through timber harvesting required for exploration and maintenance activity. The natural gas industry, including the plant, pipeline maintenance and exploration, is estimated to employ an additional 1,000 workers from outside the timber supply area.[7] Census employment data is based on place of residence so the data used for Figure 33 excludes employees who reside outside the Fort Nelson TSA, and as such the actual role of the oil and gas industry in the Fort Nelson TSA is not well reflected in Figure 33.

Tourism is also an important component of the Fort Nelson economy. The accommodation sector in Figure 33, which grew by 50% from 1991 to 1996, includes tourism, business travel, and a portion of the non-resident labour force. Tourism would also contribute to other sectors, for example the retail sector. Fort Nelson's proximity to the Alaska Highway provides the major source of tourism traffic. Tourists are also drawn to the area's guide outfitting and large-game hunting opportunities. Fifteen guide outfitting companies currently operate in the region offering hunting, sport fishing and other outdoor recreational pursuits.

The public sector, as a share of the labour force, is small compared to other areas of the province. In 1996, the public sector supported approximately 13% of the workforce, down from 18% in 1991. The public sector consists of municipal, regional, provincial and federal government employees, including school district and hospital employees. Provincially, the public sector accounts for approximately 21% of the labour force.

The employment percentages presented do not reflect income levels and the dependence of one sector on the spending of another. For example, since the business services and TCU sectors of Figure 33 provide services to the forestry and public sectors, a portion of their business depends on spending by companies and employees of the forestry and public sectors. Sectors with higher incomes and spending levels tend to purchase more supplies and services and, therefore, support more business activity.

Employment multipliers illustrate this spending effect: a larger multiplier indicates that the business activity supporting each direct job will subsequently support more business activity at supply and service companies. For example, estimates by the Ministry of Finance and Corporate Relations indicate that every 100 full-time direct forestry jobs in the Fort Nelson Forest District support another 42 to 54 indirect and induced jobs* within the TSA, depending on the forestry activity (harvesting or processing). Every 100 mining, oil and gas jobs support an additional 56 positions. In contrast, every 100 public sector jobs support approximately 25 indirect and induced positions, and every 100 tourism jobs support 17 additional jobs. All jobs are assumed to be full-time positions. The larger multipliers are a result of larger revenue earnings and spending patterns by businesses and their employees. Table 8 compares employment multipliers for sectors of the forest district's economy.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

7. Fort Nelson LRMP base case.

Table 8. Comparison of employment multipliers, Fort Nelson TSA, 1996

Sector	Employment multiplier
Forestry (harvesting and processing)	1.42-1.54
Mining, oil and gas	1.56
Agriculture and food	1.12
Tourism	1.17
Public sector	1.25
Construction	1.42

Source: Ministry of Finance and Corporate Relations (1999) 1996 British Columbia Local Area Dependencies and Impact Ratios. Province of B.C.

8.2 Fort Nelson TSA forest industry

8.2.1 Current allowable annual cut

The current allowable annual cut (AAC) in the Fort Nelson TSA was set in January 1995, at 1.5 million cubic metres. The AAC is comprised of a partition, which specifies a coniferous volume of 600 000 cubic metres and a deciduous volume of 900 000 cubic metres. The following table provides a breakdown of the AAC by licence type. Prior to 1995, the AAC was 972 000 cubic metres, divided into a coniferous volume of 750 000 cubic metres and a deciduous volume of 222 000 cubic metres.

Table 9. Fort Nelson allowable annual cut (AAC) apportionment, by licence type

Licence type	AAC	% of total
Coniferous (conventional)		
Forest licences replaceable	538 973	89.8
Small business forest enterprise program (SBFEP)	59 427	9.9
Woodlot licences	1 600	0.3
Coniferous subtotal	600 000	100.0
Deciduous		
Forest licences, replaceable	134 743	15.0
Small business forest enterprise program (SBFEP)	14 857	1.6
Forest service reserve	9 616	1.1
Woodlot licences	400	< 0.1
Forest licences, non-replaceable	129 384	14.4
Pulpwood agreements*, TSL	611 000	67.9
Deciduous subtotal	900 000	100.0
Total AAC	1 500 000	

Source: Ministry of Forests.

Pulpwood agreements
An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.

8.2.2 Fort Nelson TSA harvest history

Table 10 summarizes the volume of timber harvested in the Fort Nelson TSA from 1994 to 1998. The actual volume of timber harvested is an important indicator of forestry activity in the TSA. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year determines the level of economic activity. Differences in annual harvest levels are the result of provisions for cut-control[8] that allow licensees to vary their harvests based on operating and market conditions. If actual annual harvest levels are consistently less than the AAC, then forestry activity is below its full potential.[9]

In 1998, 1.13 million cubic metres were harvested from the Fort Nelson TSA, down from 1.59 million cubic metres in 1997. From 1994 to 1998, the harvest level in the Fort Nelson TSA averaged just over 1.2 million cubic metres per year. Timber from non-Crown lands (private lands and Indian Reserves) averaged approximately 33 000 cubic metres per year over the same period. The share of deciduous species as a percentage of the total harvest has steadily increased from 15% in 1994 to 51% in 1998, reflecting the increase in deciduous volumes made available in the previous timber supply review and Slocan Forest Products Ltd. construction of an oriented strand board plant in Fort Nelson.

With operations currently suspended at the Canadian Chopstick Manufacturing Company (CCMC) plant as of April 1997, Slocan, and its subsidiary Tackama Forest Products, are the only wood products processors currently operating in the Fort Nelson TSA. However, timber continued to be harvested under the CCMC forest licence in 1997 and 1998.

Table 10. Volumes billed, by licence type, 1994-1998

Tenure	(Cubic metres)					
	1994	1995	1996	1997	1998	Average 1994-1998
Forest licences	856 598	754 195	1 156 810	1 054 513	539 934	872 410
Timber Sale Licence (TSL)[a]	0	0	13 603	307 375	406 981	145 592
Small business forest enterprise program (SBFEP)	75 311	76 421	84 311	89 224	27 569	70 567
Other[b]	85 349	77 769	146 920	137 792	153 368	120 240
Total	1 017 258	908 385	1 401 644	1 588 904	1 127 852	1 208 809
AAC	972 000	1 500 000	1 500 000	1 500 000	1 500 000	

Source: Ministry of Forests.

(a) Volumes reflect start-up of Slocan's oriented strand board plant and should remain at average 1997 to 1998 levels.

(b) Other consists of cutting permits such as rights-of-way, road permits, and other small temporary permits.

8. Cut control allows licensees to vary the volume between annual harvest and AAC by +/- 50 % per year, and by +/-10% over a 5-year cut control period.

9. Full potential referred to here is based on the allocated volumes of the AAC, and is not necessarily the same as full economic potential which is based on the international market for wood products.

8.2.3 Fort Nelson TSA major licensees

Slocan Forest Products Ltd. (Slocan)

Slocan Forest Products Ltd. (Slocan), under its subsidiary Tackama Forest Products Ltd., has a replaceable Forest Licence to harvest 673 716 cubic metres per year, 80% of which is coniferous. Slocan also has a non-replaceable forest licence for an annual volume of 60 000 cubic metres of deciduous, and a pulpwood agreement for an annual volume of 610 000 cubic metres of deciduous. Slocan has numerous tenures throughout the province totalling some 6.8 million cubic metres and is a major producer of lumber, pulp, veneer and plywood, and oriented strand board. Table 11 outlines Slocan's recent Fort Nelson TSA harvest history and 1996 to 1998 average employment statistics in person-years.

Slocan's Fort Nelson TSA licences supply its local mills with approximately 85% of their timber requirement; the remainder comes from the Fort Nelson SBFEP, private, and out-of-province sources. In 1998, the Tackama lumber mill processed almost 339 000 cubic metres of timber; the veneer/plywood mill processed approximately 335 000 cubic metres, and the oriented strand board mill, which began operations in 1996, processed approximately 610 000 cubic metres of timber. The three mills employed close to 540 people in 1998. These production and employment levels are down from 1997, as a result of the downturn in wood products markets.

In 1998, Slocan shipped 80% (72% in 1997) of its lumber to the United States, and in 1997 and 1998 shipped 93% of its plywood production within Canada. In 1997 and 1998, Slocan shipped 79% of its oriented strand board production to the United States.

Table 11. Slocan/Tackama Fort Nelson TSA volumes billed and employment statistics

AAC (set in 1995)	1 343 716 cubic metres
1998 volumes billed	911 236 cubic metres
1994-1998 average volumes billed	913 000 cubic metres
Employment (1996-1998 average person-years)	
Harvesting and administration	295
Transport, road building and maintenance	175
Silviculture	56
Processing	544
Total	1,070

Note: The employment figures are based on a survey of Slocan operations and relate to an average 1996 to 1998 volume billed of 1.05 million cubic metres from the Fort Nelson TSA. Processing employment reflects Slocan/Tackama mill operations in the Fort Nelson TSA, 1996 to 1998. Volume estimates include forest licences, pulpwood agreement, and cutting permits.

Other licensees and processing facilities

Timber continued to be cut in 1997 and 1998 under the Canadian Chopstick Manufacturing Company (CCMC) forest licence; however, only 41 250 cubic metres were billed in 1998, compared to over 185 000 in 1997 and 175 000 in 1996. From 1994 to 1998, an average of approximately 118 765 cubic metres were cut annually under this licence. During CCMC's operation, approximately 40% of the timber harvested under its licence was suitable for manufacture into chopsticks. A portion of the remaining volume was shipped to the Cariboo forest region. The CCMC forest licence supported approximately 30 to 40 person-years of direct harvesting and silviculture employment, and 180 person-years of direct processing employment. In April 1997, the Canadian Chopstick Manufacturing Company (CCMC) plant suspended operations, affecting the 180 mill employees; this figure does not include harvesting employment. Company representatives cited lower cost competition and a slow Asian market as reasons for this shutdown. Employment at the CCMC plant has not been included in the assessment of future employment in Fort Nelson; however, the volume of timber remains available for harvest and is included in this analysis.

The Small Business Forest Enterprise Program (SBFEP) is apportioned 59 427 cubic metres of coniferous-leading stands and 14 857 cubic metres of deciduous-leading stands. From 1994 to 1998, the annual harvest under the SBFEP averaged approximately 70 567 cubic metres. Approximately 70% of the timber harvested under the SBFEP is processed at one of Slocan's Fort Nelson mills. The remainder is processed outside the TSA. From 1996 to 1998, the SBFEP supported approximately 70 person-years of direct harvesting and silviculture employment and an additional 90 person-years of direct processing employment.

8.2.4 Forest sector employment and employment coefficients

The preceding harvesting and employment information is used to develop employment coefficients, which are used to project future employment levels in the forestry sector. For this purpose, the forestry sector has been divided into three sub-sectors:

- harvesting and other woodlands-related employment including falling, log transport, log salvage, log scaling, harvest planning and administration;
- silviculture employment such as planting, surveying, and other basic and intensive silviculture activities, such as spacing, fertilizing and pruning*; and,
- primary timber processing employment at lumber mills, veneer and plywood mills, shake and shingle mills, chip mills, log home mills, and pulp and paper mills.

Harvesting and silviculture employment

The harvesting component of the forest industry includes both company and contract loggers and is the most closely tied to the AAC. Consequently, harvest level changes will affect this sub-sector first. The predominant silviculture system used is clearcut using feller bunchers, some hand falling, and skidders. The majority of the harvesting takes place during the winter months, although summer logging does occur on a limited basis. Approximately 70% of the harvesting workforce resides in the Fort Nelson TSA and the remaining 30% comes from forest districts to the south or from other provinces.

Silviculture activity is split into basic and enhanced work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Enhanced silviculture includes spacing, fertilizing, and pruning. For the TSA, licensees are responsible for basic silviculture on areas harvested under Forest Licences; the provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is normally completed by silviculture contractors. Forest Renewal BC provides funding for silviculture, resource inventory, and restoration activity in the Fort Nelson TSA. Approximately 80% of the silviculture workforce currently comes from outside the Fort Nelson TSA.

Pruning
The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.

8 Socio-Economic Analysis

The 1993 *Socio-economic Evaluation of Fort Nelson TSA Timber Harvest Scenarios* found that the previous AAC of 972 000 cubic metres supported approximately 300 person-years of direct harvesting and silviculture employment. Data compiled for this timber supply review indicate that from 1996 to 1998, the average level of direct harvesting and silviculture employment associated with Crown timber harvested from the Fort Nelson TSA was approximately 483 person-years; however, this figure does not fully reflect recent reductions in silviculture activity throughout the TSA.

Processing employment

The Fort Nelson TSA harvest supports processing employment not only in the Fort Nelson TSA, but also in other TSAs where timber and residual chips are shipped and processed. Approximately 90% of the timber harvested from the Fort Nelson TSA remains in the TSA and is processed at one of Slocan's mills. This supply provides Slocan's Fort Nelson operations with approximately 85% of its requirements. Residual coniferous chips produced at local mills are shipped to the Fibreco pulp mill in Taylor, just south of Fort St. John. The majority of deciduous chips and logs are processed at Slocan's Fort Nelson oriented strand board plant.

The 1993 *Socio-economic Evaluation of Fort Nelson TSA Timber Harvest Scenarios* found that the previous AAC of 972 000 cubic metres supported approximately 370 person-years of direct processing employment across the province. Data collected for this review indicate that from 1996 to 1998, the average harvest of approximately 1.372 million cubic metres supported an average of 621 person-years of processing employment across the province. These figures reflect the suspended operations of the Canadian Chopstick Manufacturing Company (CCMC) plant and the opening of Slocan's oriented strand board plant.

Forest Service employment

The Fort Nelson TSA is administered by the Fort Nelson Forest District office located in Fort Nelson. Currently 33 people work in the forest district office. Ministry of Forests' staff are involved with the administration and enforcement of government forest management policy, and planning related to the Small Business Forest Enterprise Program (SBFEP).

Fort Nelson TSA employment and employment coefficient summary

Table 12 summarizes the employment supported by the 1996 to 1998 average harvest in the Fort Nelson TSA and the corresponding employment coefficients. Coefficients have been calculated at a TSA and provincial level to highlight the importance of the forestry sector within the Fort Nelson TSA and to identify the contribution that the Fort Nelson TSA's forestry sector makes to the provincial economy. The two levels are defined as follows:

1) TSA employment and employment coefficients, which comprise residents of the Fort Nelson TSA who are employed in the forestry sector within the Fort Nelson TSA and who rely on the Fort Nelson TSA timber supply; and,

2) Provincial employment and employment coefficients, which comprise all forestry sector employment in the province that relies on the Fort Nelson timber supply, including both residents of the Fort Nelson TSA and those who live elsewhere.

Employment is divided into direct, indirect and induced components; the sum of the components is the total impact. The coefficients are expressed as the number of full-time jobs, or person-years, per 1000 cubic metres of timber harvested. Indirect and induced employment figures were derived using employment multipliers developed by the Ministry of Finance and Corporate Relations.

More detailed information regarding employment coefficients and multipliers is presented in Appendix B, "Socio-Economic Analysis Background Information."

Table 12. Fort Nelson TSA average forest sector employment and employment coefficients, 1996-1998

Activity	Fort Nelson TSA employment (person-years)	Fort Nelson TSA coefficients[10] (person-years/ '000s cubic metres)	Provincial employment (person-years)	Provincial coefficients[10] (person-years/ '000s cubic metres)
Harvesting	276	0.20	386	0.28
Silviculture	14	0.01	97	0.07
Processing	497	0.36	621	0.45
Total direct	787	0.57	1,104	0.80
Indirect / induced	359	0.26	1,296	0.95
Total	1,146	0.83	2,400	1.75

Note: Employment estimates are in person-years based on average 1996 to 1998 employment levels and the 1996 to 1998 average annual harvest of 1.372 million cubic metres.

8.2.5 Fort Nelson TSA employment income

From 1996 to 1998, the average annual income for forest sector employees in the province was approximately $46,030.[11] For indirect and induced employment the average annual income was approximately $34,075. The direct income associated with the forest sector in the Fort Nelson timber supply area averaged $50.8 million per year and indirect and induced income averaged $44.2 million per year. Combined, total income associated with the Fort Nelson TSA harvest averaged $95.0 million per year. Table 13 shows income levels, average wages and salaries, and total income per thousand cubic metres.

Table 13. Average direct and indirect/induced incomes and total employment income, 1996-1998

	Average annual wage/salary (1998 dollar value)	Total annual income ($ millions)	Total annual income per 1000 cubic metres
Direct	46,030	50.8	36,810
Indirect / induced	34,075	44.2	32,030
Total		95.0	68,840

Source: Statistics Canada, Survey of Employment Payroll and Hours.

10. Other employment coefficients may be found in other documents for the same or similar areas. A difference in ratios can occur for several reasons, such as using different sources of employment data and rounding of estimates, dividing employment by a different harvest level, using a different definition of a full time position, and changing the definition of forestry sub-sectors. However, the relative of impacts associated with a timber supply change should be similar.

11. Statistics Canada. Survey of Employment Payrolls and Hours. $46,030 is a weighted average based on the forestry sector activity supported by the Fort Nelson TSA.

8.2.6 Provincial government revenues

The provincial government receives various taxes and other revenues from the forest industry. The forest industry pays stumpage, royalties, and rents to the provincial government for the rights to timber and its use, and other industry operating taxes such as logging, corporate income, property, and sales taxes. The provincial and federal governments also receive revenues from forestry employees through income taxes. The oil and gas industry also contributes to these stumpage payments through clearing of forested lands to support their operations.

From 1996 to 1998, the forest industry in the Fort Nelson TSA paid an average of approximately $15.7 million per year in stumpage, royalty and rent to the provincial government. This amount includes $1.7 million per year contributed by the oil and gas industry. Other government revenues accounted for $12.5 million per year and total employment supported by the Fort Nelson TSA harvest provided total annual provincial income taxes worth approximately $8.0 million.

Table 14. Average provincial government revenues, 1996-1998

	Average annual revenue 1996-1998 ($1998 millions)	Annual revenue per 1000 cubic metres
Stumpage, rents and royalties	15.7	11,350
Industry taxes	12.5	9,050
Provincial income tax	8.0	5,800
Total government revenues	36.2	26,200

Note: Based on an average 1996 to 1998 average annual harvest of 1.372 million cubic metres.

8.3 Socio-economic implications of the base case harvest forecast

The socio-economic analysis focuses on harvest level changes in the short- to medium-term of 10 to 30 years from now and considers:

- the implications of alternative harvest levels for both the Fort Nelson TSA and the province;
- possible impacts on communities within the TSA;
- timber requirements of processing facilities within the Fort Nelson TSA; and,
- regional timber supply implications.

The socio-economic analysis considers average levels of forest industry related activity that the base case harvest forecast could support. Impacts associated with future harvest levels are calculated using employment, income and revenue coefficients (per 1000 cubic metres). This method assumes that the current role of the forest industry in the provincial economy continues and that labour productivity will not change. This means that, for example, employment levels in the future are predicted based on today's relationship between employment and the volume of timber harvested and processed. The analysis also assumes that the proportions of harvesting, silviculture and timber processing employment will remain constant and that the types and proportions of wood products manufactured will remain the same.

While this method is reasonably accurate for short-term forecasts (within the next three to five years), employment coefficients 20 years from now may be very different due to changes in market conditions, timber processing technologies, etc. The analysis provides an indication of the magnitude of impacts to employment, employment income and provincial government revenues, within a constantly changing socio-economic environment.

8.3.1 Short- and long-term implications of alternative harvest levels

TSA employment and income impacts

Fort Nelson TSA employment and income includes workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by Fort Nelson TSA timber processed at mills outside the TSA. Table 15 indicates the employment and income the current AAC can support when fully harvested and processed, and the levels that could be supported in the short- to medium-term by the harvest volumes suggested in the base case forecast.

The current AAC of 1 500 000 cubic metres can support approximately 855 person-years of direct harvesting, silviculture and processing employment within the TSA and a further 390 person-years of indirect and induced employment.

Without considering the critical issues surrounding the base case harvest forecast identified in the analysis report it would appear a harvest level of 2 276 000 cubic metres per year could be established. Such a harvest level could potentially support approximately 1,128 person-years of direct employment and a further 514 person-years of indirect and induced employment within the Fort Nelson TSA. This is an increase of 273 person-years of direct employment and between 77 and 124 person-years of indirect and induced employment. Annual employment income would increase to approximately $69.4 million from $52.7 million.

Increasing the harvest to 2 276 000 cubic metres could lead to the construction of new milling capacity; however, where the extra timber would be milled and by whom is uncertain. As a result, the TSA level analysis assumes that no new milling capacity would be constructed in the Fort Nelson TSA and the 1,128 person-years identified in the previous paragraph includes 650 person-years of direct processing employment (the remaining 478 person–years are harvesting and silviculture positions), which is about the maximum number that could be currently employed at TSA mills, given each mill operates at full capacity. Additional processing employment associated with a new mill is included in the provincial impacts. Whether or not the timber would be harvested and processed at all depends on a number of factors, such as timber accessibility, harvest and transportation costs, prices, market demand, and future expectations.

The potential community and related impacts of the harvest forecast are discussed in more detail in Section 8.3.2, "Community level impacts."

Provincial employment and income impacts

Provincial employment and income impacts include all the activity supported by the Fort Nelson TSA harvest, regardless of processing location and place of residence. The current AAC of 1 500 000 cubic metres could support approximately 1,200 person-years of direct employment across the province and an additional 1,425 person-years of indirect and induced employment.

Again without consideration for the critical issues surrounding the base case harvest forecast, potentially increasing the harvest to 2 276 000 cubic metres per year could increase provincial employment to 1,822 person-years of direct employment and 2,163 person-years of indirect and induced employment. This is an increase from current levels of 622 person-years of direct employment and between 518 and 738 person-years of indirect and induced employment. Annual employment income would increase to approximately $158 million from $104 million.

Table 15. Socio-economic impacts of the Fort Nelson TSA base case forecast

	At current[a] AAC	Base case harvest forecast decades 1+
Timber supply (cubic metres)	1 500 000	2 276 000
Harvest level (1996-1998 average)	1 372 000	N/A
Difference from current AAC	128 000	776 000
Fort Nelson timber supply area		
Employment	(person-years)	
Direct	855	1,128
Indirect/induced	390	514
Total	1,245	1,642
Range[b] of employment gain (loss)		350 - 397
Employment income	($1998 million)	
Direct	39.4	51.9
Indirect/induced	13.3	17.5
Total	52.7	69.4
Range of income gain (loss)		15.0 - 16.7
Province[c]		
Employment	(person-years)	
Direct	1,200	1,822
Indirect/induced	1,425	2,163
Total	2,625	3,985
Range of employment gain (loss)		1,140 - 1,360
Employment Income	($1998 million)	
Direct	55.2	83.9
Indirect/induced	48.6	73.7
Total	103.8	157.6
Range of income gain (loss)		45.2 - 53.8
Provincial government revenues	($1998 million)	
Stumpage and related payments[d]	17.0	30.0
Forest industry taxes	13.6	20.6
Employee income taxes	8.7	13.3
Total	39.3	63.9
Gain (reduction) in revenues		24.6

(a) The estimates for current employment in this table differ from those in Table 12 as the figures above are based on the current AAC of 1.5 million cubic metres and Table 12 uses the average 1996 to 1998 volume of 1.372 million cubic metres.

(b) The ranges for employment and income changes take into consideration that some new workers will be local and others will move to the TSA. Local residents, although unemployed, would already receive some income through transfer payments and would spend that income locally, subsequently supporting some induced labour. New residents would introduce a full wage difference to the area thus would have a greater impact on the local economy. The actual impacts of changes in harvest levels on employment and incomes will likely fall within the specified ranges. More details are provided in Appendix B, "Socio-Economic Analysis Background Information".

(c) Provincial employment and income estimates include TSA employment and income.

(d) The increase in stumpage payments is based on an increase in coniferous volumes which are subject to higher stumpage charges than deciduous volumes. As a result, the stumpage increase does not reflect the current average Fort Nelson TSA stumpage rate.

Provincial government revenue impacts

Provincial government revenues from the forest industry include stumpage, royalties and rent payments, other taxes such as logging, corporate income, sales, property and electricity taxes, and income taxes from direct, indirect and induced employees. Under the existing tax and stumpage regimes, the current AAC of 1.5 million cubic metres if fully harvested would provide on average approximately $39.3 million annually to the provincial government.

Assuming tax, stumpage, royalty and rent rates are similar to the average rates from 1996 to 1998, the projected harvest rate of potentially 2 276 000 cubic metres per year would generate approximately $63.9 million per year in provincial government revenues.

8.3.2 Community level impacts

Due to the uncertainty related to the volume of timber that would actually be harvested in the Fort Nelson TSA, the following description of base case related community impacts should be understood as illustrative only. The following description would be the extreme case given full use of the timber supply outlined in the base case harvest forecast without consideration for the critical issues surrounding its generation.

The potential to increase the timber supply in the Fort Nelson TSA by 48% could have numerous implications for the region and its communities. The current population and labour force may not be able to meet the labour demands of the increased forestry activity, and the associated increases related to supply and service business expansion. The full extent of the additional labour requirements would depend upon the demand for the new timber supply and the location of milling activity. Thus, the actual impact on Fort Nelson TSA communities and province would depend on licensees' ability to profitably harvest and process the timber.

Assuming licensees are able to take advantage of the additional timber, direct harvesting employment could increase by approximately 220 person-years of employment. While some of these opportunities would go to local unemployed or under-employed persons, this local source of labour may not be sufficient to fill the new opportunities. Harvesting in the Fort Nelson TSA currently takes place during the winter with minor volumes harvested in the summer. This leads to a fairly short work-year with a portion of the harvesting workforce residing in communities to the south. Until the summer harvesting season is lengthened to provide for more full-year employment, migration of a harvesting related workforce may be limited. The additional timber supply could also support approximately 350 person-years of direct processing employment.

If half of the new labour requirement were to move to the Fort Nelson area, roughly 250 new workers could arrive. Given an average of 3 persons per household,[12] an influx of up to 250 forestry workers could lead to a population increase of approximately 750 persons, or 12%. The increased business activity associated with these new workers and their families could lead to an increase of another 100 indirect and induced workers, plus any family they may have.

The location of any employment increases could range from the Fort Nelson TSA to other northeast forest districts such as Fort St. John and Dawson Creek, for example, if the logs left the TSA for processing. Some of this projected increase could also appear as employment maintained at other processing facilities currently subject to supply constraints. Regardless of the location, new or more stable employment would strengthen local economies and potentially increase population levels. As Table 15 indicates, the total direct employment associated with the timber supply could be at least 1800 person-years, 50% higher than current average direct employment levels.

12. Census of Canada 1996. The average family size is for the Northern Rockies Regional District. Note these figures are averages for 1996 and the resulting projections are used for illustrative purposes only.

The increased labour requirements and economic security that would follow from a large increase in the harvest could also be accompanied by development pressures at the municipal level. If this expansion were concentrated in one area, such as Fort Nelson, the community may require investment in local infrastructure if the capacity of the town is not sufficient to handle increased housing requirements, and subsequent water, sanitary and power needs. This could require extensive planning efforts by the municipality, to prepare for housing developments, schools, and other infrastructure, for example. The demand for locally, provincially, and federally funded services would increase, thus creating a further influx into the region of new teachers, health care workers, and administrators. The job estimates in Table 15 do not include increased public sector services that would likely be demanded by a growing population.

8.3.3 Nature, production capabilities, and timber requirements of processing facilities

Approximately 85% of the timber processed at Fort Nelson mills is harvested from the Fort Nelson TSA. The remainder comes from private and out-of-province sources. The base case forecast indicates that this supply of timber for Fort Nelson mills is very secure. Both the deciduous and the coniferous timber supplies are sufficient, at least in volume, to supply the current needs of local processing facilities.

8.3.4 Regional timber supply implications

In many regions of the province, the processing industry does not rely solely on the local timber supply but on the larger region, often beyond a TSA or district boundary. In the Fort Nelson TSA, however, the timber supply from the TSA is the largest and most important source of timber to local mills. As a result, changes in other TSAs or regions will not have a significant effect on local milling capabilities. The potential increase in the Fort Nelson TSA could provide greater self-sufficiency and security for local mills and potentially in other areas of the province as well. This assumes that the new timber supply can be harvested and milled economically.

8.4 Summary

The Fort Nelson area has a healthy economy with an expanding population and labour force, and a low unemployment rate.

The Fort Nelson forest industry is an important driver of the local economy and in 1996 directly accounted for approximately 30% of the region's labour force, plus numerous other supply and service jobs throughout the area. Slocan Forest Products Ltd. and its subsidiary Tackama Forest Products are the dominant industry participants and operate a sawmill, veneer/plywood mill and oriented strand board mill. From 1996 to 1998, the forest industry in the Fort Nelson Forest District supported approximately 1,100 person-years of direct employment in the northeast portion of the province and a further 1,300 person-years of indirect and induced employment across the province. Residents of the Fort Nelson Forest District account for approximately 70% of the direct employment.

Without consideration of the critical issues surrounding the base case harvest forecast for the Fort Nelson TSA it would appear the harvest level could potentially increase to 2 276 000 cubic metres per year. This would be as a result of the coniferous volume increasing to 1 376 000 cubic metres per year from 600 000 cubic metres. The deciduous harvest is forecast to remain about the same (900 000 cubic metres per year).

If the harvest were to increase to 2 276 000 cubic metres per year, direct employment could increase by approximately 620 person-years across the province and indirect and induced employment could increase by approximately 730 person-years.

Provincial government revenues would also increase. Stumpage and related payments, industry taxes, and employee income taxes could increase to $63.9 million per year — an additional $24.6 million per year, assuming a continuation of current tax rates.

Considering the uncertainty around the identified critical issues, the base case harvest forecast may perhaps be optimistic. The actual employment and community related impacts will depend on the actual AAC set by the provincial Chief Forester and the ability of the forest industry to economically harvest and process the timber.

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Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Base case forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, and includes the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Early seral	Stands are defined as early seral if they are younger than: 40 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 40 years for coniferous stands and 20 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.
Employment coefficient	The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.
Employment multiplier	An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.
Environmentally sensitive areas	Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Forest cover objectives	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).

Forest cover requirements	Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green–up).
Forest inventory	An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.
Forest Practices Code	Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.
Forest type	The classification or label given to a forest stand, usually based on its tree species composition. Pure spruce stands and spruce-balsam mixed stands are two examples.
Free-growing	An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber, at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Indirect and induced jobs	Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.
Integrated resource management	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Land and Resource Management Plan (LRMP)	A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.
Landscape-level biodiversity	The *Forest Practices Code Biodiversity Guidebook* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mature seral	Stands are defined as mature seral if they are older than: 120 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 100 years for coniferous stands and 80 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.
Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since 1987 are classified as current NSR.
Old seral	Stands are defined as old seral if they are older than: 250 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 140 years for coniferous stands and 100 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.
Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. If someone works full-time for 90 days, he or she accounts for 0.5 person-years.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pruning	The manual removal of the lower branches of crop trees to a predetermined height to produce clear, knot-free wood.
Pulpwood agreements	An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.
Regeneration delay	The period of time between harvesting and the date by which an area is occupied by a specified minimum number of acceptable well-spaced trees.

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Rehabilitation	Removing all non-commercial cover, preparing the site and stocking it with acceptable, commercially valuable species.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Sensitivity analysis	Process that examines how uncertainty in data and management assumptions affect timber supply.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.
Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Timber supply	The amount of timber that is forecast to be available over a specified time period, under a particular management regime.
Uneconomic areas	Areas defined as unavailable for harvest for economic or terrain-related reasons. Characteristics used in defining uneconomic areas include distance from processing facilities, existing roads, difficulty of road access, and availability of suitable timber. Areas considered uneconomic can change over time as a function of changing harvesting technology and economics.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Visual sensitivity	A measure of the level of concern for the scenic quality of a landscape. Visual sensitivity ratings take into account the physical character of the landscape, as well as viewer related factors such as the number of viewers and the angle, position, and distance from which the landscape is viewed.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Wildlife tree	A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Fort Nelson TSA Timber Supply analysis. This information represents current forest management in the area.

Current management is defined as the set of land use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced, are not included in this appendix.

The purpose of the Timber Supply Review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Inventory Information

The Ministry of Forests' timber inventory and associated management information for the Fort Nelson TSA, as listed in Table A-1., were used to determine the timber harvesting land base and to model forest management activities.

Table A-1. Inventory information

Data	Source	Vintage	Updated	Scale
Forest inventory	Ministry of Forests (MoF) standard inventory file	1970	1996	1:20 000
Biogeoclimatic classification	MoF – Prince George Forest Region non-standard inventory file	1993	1996	1:250 000
Natural disturbance type (NDT)	MoF – Prince George Forest Region non-standard inventory file	1993	1996	1:250 000
Resource management zones (RMZ) (related to forest productivity and LRMP objectives)	MoF – Fort Nelson Forest District non-standard inventory file	1996	1997	1:50 000
Visual landscape inventory	MoF – Fort Nelson Forest District non-standard inventory file	1995 1992 & 1995 (see notes)	N/A	1:250 000 1:50 000
Range burns	Ministry of Environment, Lands and Parks (MELP) non-standard inventory file	1992	1992	1:250 000
Draft landscape units	MoF – Prince George Forest Region non-standard inventory file	1996	1997	1:50 000
Seismic mapping	MoF – Fort Nelson Forest District non-standard inventory file	1994	1994	1:250 000

Forest inventory

The forest cover inventory was interpreted from aerial photography. This inventory ranges between 11 and 30 years old, however, it is continuously updated for timber harvesting and silvicultural activities. Seismic information has been updated to 1994, and additional seismic lines were accounted for in the timber supply review (TSR) modelling process (see Section A.3.14, "Seismic areas"). The inventory has also been updated based on a 1994 reassessment of range burns in the western part of the district. Stand characteristics such as tree height, stocking and age have been projected to January 1, 1997 to reflect growth and aging. Therefore, despite the age of the inventory, current stand conditions are reflected, through inventory projection. At this time, no inventory audit information is available to assess the accuracy of this information.

Biogeoclimatic (BEC) subzones and natural disturbance types (NDT)

This non-standard layer contains information on geographic areas with similar patterns of energy flow, vegetation and soils as a result of broadly homogenous macro-climate. The initial biogeoclimatic classification, completed by 1990, was used for the analysis. The biogeoclimatic classification is currently being revised to include wet-land sites and a more complete classification for Alpine Tundra and Spruce Willow Birch zones. Natural disturbance types were derived based on these biogeoclimatic units, and reflect patterns of fire history and other disturbances.

Resource management zones (RMZ)

Resource management zones were defined in the Fort Nelson Forest District LRMP, which was approved in 1998. These resource management zones were amalgamated into four management categories for the analysis, reflecting expected differences in productivity and harvest history.

Visual landscape inventory

Detailed (1:50,000) visual landscape inventories were completed for the Klua Lakes viewshed in 1992, and for a portion of the Alaska Highway corridor from Beaver Creek to Summit Lake in 1995. Also in 1995, a broad mapping of all the visually sensitive areas in the district was completed at a scale of 1:250,000. Since this time the district manager has declared these areas as "scenic areas" for consideration in all forestry planning activities. As well visual quality objectives (VQOs) for the Klua Lakes and Alaska Highway viewshed have been established.

Range burns

Range burns are prescribed fires used by the Ministry of Environment, Lands and Parks (MELP) staff to create grassland-forest complex habitat that provides grazing opportunities for domestic horses and some wildlife (see Section A.3.11). MELP has identified areas managed with range burns in a geographic information system (GIS). These areas are identified on the inventory data set used for the analysis (BURNS = B).

Draft landscape units

In 1998, the Fort Nelson TSA was divided into 72 draft landscape units (LUs) for landscape unit planning. The recent boundary changes has added 12 landscape units to the TSA. The purpose of LU planning is to ensure that representative forests are maintained through time to protect biodiversity across the landscape. The boundaries of these LUs were designed to encompass areas with similar physical and biodiversity characteristics.

Seismic mapping

The forest inventory contains information on seismic activity up to 1994. To reflect forest depletion from seismic activity, a geographic information system (GIS) was used to buffer the seismic lines to a width of seven metres.

A.2 Zone and Analysis Unit Definition

A.2.1 Management zones and tracking of multiple objectives (grouping)

Management zones were used to define areas subject to adjacency, visual and seral-stage representation (biodiversity) objectives within the Fort Nelson TSA. These management objectives were reflected by forest cover objectives in the model (see Section A.4.4, "Forest cover requirements"). Areas subject to management objectives may be geographically separate ('zones' in FSSIM), or may wholly or partially overlap ('groups'). For this analysis, areas subject to management objectives are:

- landscape units;
- unique biogeoclimatic subzone and variant combinations within a landscape unit; and,
- areas of visual significance.

When the analysis was undertaken, the Fort Nelson TSA contained 72 landscape units, each a unique spatially defined area in which forest cover requirements to approximate adjacency objectives were applied. The Kechika addition, covering 12 landscape units, was recently added to the TSA and therefore not included in this analysis. The area is remote and no harvesting is expected over the next several years. The area will be incorporated into the next timber supply analysis for the TSA. Within each landscape unit, biogeoclimatic zone/subzone/variant combinations, as listed below, were defined. This resulted in 243 unique spatially defined areas on which the seral-stage requirements consistent with the *Landscape Unit Planning Guide* were assessed:

- NDT 2 SWBmk;
- NDT 3 BWBS coniferous-leading stands;
- NDT 3 BWBSdk2 coniferous-leading stands;
- NDT 3 BWBSmw1 coniferous-leading stands;
- NDT 3 BWBSmw2 coniferous-leading stands;
- NDT 3 BWBSwk3 coniferous-leading stands;
- NDT 3 BWBSdk2 deciduous-leading stands;
- NDT 3 BWBSmw1 deciduous-leading stands;
- NDT 3 BWBSmw2 deciduous-leading stands;
- NDT 3 BWBSwk3 deciduous-leading stands;

Within each landscape unit, visual quality zones as listed below were defined. This resulted in 147 unique spatially defined areas on which the visual objectives were assessed:

- Retention visual objectives;
- Partial retention visual objectives;
- Modification visual objectives; and,
- Maximum modification visual objectives.

A.2 Zone and Analysis Unit Definition

Biodiversity seral-stage objectives were applied to forested area both within and outside the timber harvesting land base in each biogeoclimatic variant in each landscape unit. The forest cover requirements for adjacency were applied only to the timber harvesting land base within a landscape unit. Forest cover requirements for visual objectives were applied to visually sensitive forested area both within and outside the timber harvesting land base in each landscape unit. Section A.4.4, "Forest cover requirements" contains more details on analysis methods associated with these management objectives.

The Fort Nelson TSA has also been divided into five geographically-defined zones to reflect the general intent of the Fort Nelson LRMP and differences in productivity (See Sections A.5, "Volume Estimates for Existing Stands" and A.6, "Volume Estimates for Future Managed Stands"). Table A-2 summarizes the five productivity zones defined for this analysis.

Table A-2. Productivity zones reflecting LRMP objectives

	Resource management zone	Total area (hectares)	Timber harvesting land base (hectares)
1	Integrated resource management category	5 670 736	777 274
2	Integrated resource management in major river corridors	248 053	102 124
3	Special management category	1 966 518	26 856
4	Special management in major river corridors	149 413	18 594
5	Park	179 010	0

The integrated resource management areas cover the eastern portion of the TSA, the lowlands, and the foothills, while the special management areas cover the western portion of the TSA including the Rocky Mountains. The two major river zones delineate major low lying river corridors, while the other areas are characterized by higher elevations.

A.2 Zone and Analysis Unit Definition

A.2.2 Analysis unit characteristics

To simplify the analysis, individual forest stands were grouped into analysis units—which represent stands dominated by specific tree species—according to inventory type group (ITG).

Table A-3. shows the species and ITG composition, as well as the area in the timber harvesting land base, for each analysis unit. Separate timber volume tables were generated for each analysis unit in each of the four productivity zones (see Table A-2., "Productivity zones", Table A-25., "Timber volume tables for existing natural stands" and Table A-26., "Timber volume tables for future managed stands"). Since parks are not in the timber harvesting land base, no timber yield tables were generated for those areas. The same analysis units and associated yield tables were used for all landscape units within each productivity zone.

Table A-3. Analysis units

Analysis unit number	Leading species	Inventory type groups	Timber harvesting land base (includes NSR) (hectares)	Per cent of total timber harvesting land base
01	Spruce	21, 23, 24	258 571	28.0
02	Spruce/pine	25	24 416	2.6
03	Spruce/deciduous	26	166 939	18.0
04	Aspen/coniferous	41	114 522	12.4
05	Aspen/deciduous	42	239 675	25.9
06	Pine	27-29, 30	52 538	5.7
07	Pine/deciduous	31	16 577	1.8
08	Cottonwood/coniferous	35	12 517	1.4
09	Cottonwood/deciduous	36	35 449	3.8
10	Spruce/larch	22	1 012	0.1
11	Balsam fir	18-20	2 631	0.3
	Total		924 849	100.0

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Fort Nelson TSA. One of the first steps in this timber supply analysis was to define this portion of the TSA, called the timber harvesting land base for the analysis. This land base was derived by removing types of land and forest where timber harvesting is not likely to occur under current management. All remaining land contributes to the timber harvesting land base.

Table 3, "Timber harvesting land base for the Fort Nelson TSA" in the main report lists the areas in each category of land examined when establishing the timber harvesting land base. It should be noted that one area could have more than one characteristic that would result in it exclusion from the timber harvesting land base. For example, it could be both a park and occupied by non-commercial cover.

The areas in Table 3 were derived by examining the characteristics of the land in a particular order. The areas listed in the table would be different if the characteristics were removed in a different order. The characteristics of each of these types are discussed below in the order in which examined during land base definition.

A.3.1 Land not managed by the B.C. Ministry of Forests

The ownership codes (OWN and SCHEDULE) on the inventory file were used to determine which areas are not managed by the B.C. Ministry of Forests. This category includes areas such as parks, ecological reserves, private land and various special use permit areas. Forest considered to be within a Crown land forest management unit (ownership code 62 C) can potentially contribute to timber harvesting. Within the Fort Nelson TSA, 213 088 hectares are not classified as 62 C and have been removed from the land base considered available for timber supply. Table A-4. summarizes the Fort Nelson TSA by ownership.

Table A-4. Land not managed by the B.C. Ministry of Forests for timber supply due to ownership

Ownership classification	Total area (hectares)
40-N Private	15 267
50-N Federal Reserve	559
52-N Indian Reserve	10 282
60-N Ecological Reserve	1 761
61-C UREP (> 100 hectares)	1 268
61-N UREP (< 100 hectares)	870
63-N Park class A	141 315
67-N Park or equivalent	37 588
69-C Miscellaneous reserves	3 943
69-N Miscellaneous reserves	216
99-N Miscellaneous leases	18
Total	213 088

A.3 Definition of the Timber Harvesting Land Base

A.3.2 Non-forested land

A total of 3 808 885 hectares classified as non-productive or non-forest (TYPID_PR = 6) were excluded from the timber harvesting land base. These categories include areas covered by sparse alpine forest, ice, swamps, water, and rock. (An additional 163 604 hectares of non-productive or non-forest were removed in the ownership reduction).

A.3.3 No typing available

Small areas within the inventory file with incomplete or missing inventory information are considered not to contribute to timber harvesting. After the previous exclusions, 1208 hectares of these non-typed (TYPID_PR = 8) areas were excluded from the timber harvesting land base.

A.3.4 Naturally disturbed areas

Some land classified within the inventory as not satisfactorily restocked (NSR) has been disturbed naturally (wildfire) rather than by timber harvesting. These naturally-disturbed (non-harvesting related) NSR areas can be identified on the inventory as areas with a type identity label (TYPID_PR) of 4, and no history of harvesting or silviculture activity. A total of 107 555 hectares were deducted when deriving the timber harvesting as naturally disturbed areas.

A.3.5 Non-commercial (brush) cover

Non-commercial brush types (TYPID_PR = 5) cover a total of 511 797 hectares. These areas are considered unlikely sites for timber production without rehabilitation efforts. Areas within which rehabilitation of non-commercial brush has occurred are included in the timber harvesting land base. Areas planned for future rehabilitation efforts are incorporated into the timber harvesting land base as described in Section A.4.9, "Rehabilitation of problem forest types, and non-commercial cover areas." Non-commercial brush areas that are not subject to rehabilitation were not included in the timber harvesting land base. About 7600 hectares classified as non-commercial cover have a history of logging. For these areas it was assumed that the non-commercial cover label was not correct, and they were included in the timber harvesting land base.

A.3.6 Non-merchantable forest types

Non-merchantable forest types are stands that may be physically operable, but are currently economically marginal or infeasible to utilize. They may also simply reflect minor errors in the inventory file depicting species that do not naturally occur within the TSA. For the base case, 169 965 hectares of non-merchantable types were excluded from the timber harvesting land base. Table A-5. shows the criteria used for excluding non-merchantable forest types.

A.3 Definition of the Timber Harvesting Land Base

Table A-5. Non-merchantable forest types criteria

Leading species	Inventory type group	Reduction per cent (%)
Fir, cedar, hemlock	1–17	100
Larch	33–34	100
Alder, maple, birch	38–40	100

A.3.7 Sites with low timber growing potential

For the Fort Nelson TSA analysis, sites were excluded from the timber harvesting land base if they do not currently have a minimum volume per hectare, or would not be capable of producing a minimum timber volume within a specified time. Site index thresholds were used for the exclusions. The minimum site index thresholds were based on the attributes of stands harvested over the past 5 years, as well as the minimum site productivity required to achieve a specified tree height and volume by the regional priority cutting age for the stand type. A total of 1 875 661 hectares were removed for low timber growing potential, while an additional 3 012 747 hectares with low growing potential were removed in previous reductions. The stands excluded from the base case timber harvesting land base due to low timber growing potential are described in Table A-6. Tables A-7 and A-8 provide volume and site index values corresponding to the lower and upper bounds of uncertainty used for the increased and decreased land base sensitivity analyses.

Table A-6. Description of sites with low timber growing potential for the base case

Species[a]	Inventory type group	Characteristics for establishing minimum productivity			Minimum site index (metres)	Reduction per cent (%)
		Age (years)	Height (metres)	Volume (m^3/hectare)		
Spruce	21 – 26	121	20	140	10.8	100
Pine	27 – 31	81	20	140	16.4	100
Aspen	41, 42	81	20	140	17.7	100
Cottonwood	35, 36	81	20	140	14.0	100
Balsam	18 – 20	121	N/A	140	10.7	100

(a) Birch leading stands (ITG = 40) with a site index of 17.0 or greater were added to the timber harvesting land base for a sensitivity analysis. These birch stands obtain heights of at least 16 metres and volumes of at least 40 cubic metres per hectare by 51 years.

Table A-7. Criteria describing the lower range of uncertainty for low timber growing potential for the increased land base sensitivity analysis

Species	Inventory type group	Characteristics for establishing minimum productivity			Minimum site index (metres)	Reduction per cent (%)
		Age (years)	Height (metres)	Volume (m^3/hectare)		
Spruce	21 – 26	121	20	100	9.2	100
Pine	27 – 31	81	20	100	13.7	100
Aspen	41, 42	81	20	100	15.0	100
Cottonwood	35, 36	81	20	100	11.4	100
Balsam	18 – 20	121	N/A	100	8.8	100

Table A-8. Criteria describing the upper range of uncertainty for low timber growing potential for the decreased land base sensitivity

Species	Inventory type group	Characteristics for establishing minimum productivity			Minimum site index (metres)	Reduction per cent (%)
		Age (years)	Height (metres)	Volume (m^3/hectare)		
Spruce	21 – 26	121	20	180	12.0	100
Pine	27 – 31	81	20	180	18.4	100
Aspen	41, 42	81	20	180	19.6	100
Cottonwood	35, 36	81	20	180	16.8	100
Balsam	18 – 20	121	N/A	180	12.4	100

A.3.8 Alpine (not previously accounted for)

High elevation areas as identified by the alpine tundra and subalpine parkland biogeoclassification Natural Disturbance Type (NDTYPE = 5) are not included in the timber harvesting land base. A total of 718 hectares were removed from the timber harvesting land base as alpine tundra and subalpine parkland. An additional 865 210 hectares of alpine tundra and subalpine parkland were removed in previous reductions.

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Estimated area in riparian reserves and riparian management zones

To account for protection of riparian and stream values within the Fort Nelson TSA, 8.1% of all coniferous-leading stands and 4.1% of all deciduous-leading stands were excluded from the timber harvesting land base. Riparian objectives from the Forest Practices Code *Riparian Management Area Guidebook* were used to derive this reduction, as described in Table A-9. A brief description of the method used to generate the reduction percentages follows the table.

Table A-9. Riparian reserve and riparian management zones

Leading species	Stream classification	Width of zone (metres)		Per cent reduction (%)	
		Riparian reserve	Riparian management zone	Riparian reserve	Riparian management zone
Coniferous	S1 large rivers	0	100	N/A	70
	S1 streams	50	20	100	50
	S2 streams	30	20	100	50
	S3 streams	20	20	100	50
	S4 streams	0	30	N/A	25
	S5 streams	0	30	N/A	25
	S6 streams	0	20	N/A	5
	W1 Wetland	10	40	100	7
	W3 Wetland	0	30	100	7
	C Lake[a]	10	N/A	100	7
Deciduous	S1 larger rivers	0	100	N/A	10
	S1 streams	50	20		
	S2 streams	30	20		
	S3 streams	20	20	100	50
	S4 streams	0	30	N/A	25
	S5 streams	0	30	N/A	25
	S6 streams	0	20	N/A	5
	W1 Wetland	10	40	100	7
	W3 Wetland	0	30	100	7
	C Lake [a]	10	N/A	100	7

(a) Lake reserve area is combined with S1 to S3 stream reserve area. It is assumed that all L1 Lakes are equivalent to class C and have a reserve width of 10 metres (as established by the forest district manager and the *Prince George Regional Lakeshore Guidelines*).

A.3 Definition of the Timber Harvesting Land Base

As in many cases throughout the province, a comprehensive stream inventory is not available for the Fort Nelson TSA. To approximate the reduction needed to account for riparian reserve and management zones within the TSA, a preliminary study was completed using seven mapsheets representative of the TSA for coniferous-leading stands, and three mapsheets representative of the TSA for deciduous-leading stands. Stream classes for these mapsheets were determined by stream order and stream gradient (to indicate the presence of fish). Then, a geographic information system (GIS) was used to buffer the streams, and determine the riparian reserve and management zone area by stream classification. The per cent area reductions were established after summarizing the areas by stream class for the coniferous and deciduous forested land base. For the study, the coniferous operable forest for the seven mapsheets was 31 633 hectares, and the deciduous operable forest for the three mapsheets was 6170 hectares.

The overall average value listed in the *Riparian Management Area Guidebook* for reduction on wetlands and lakes management zones is 25%, however, the district plans are to follow the recommended best management practices from the *Guidebook* (Table 16) for the SWB and BWBS biogeoclimatic zones resulting in much lower reductions of 7%.

A.3.10 Environmentally sensitive areas (ESAs)

The forest inventory file includes a rating of environmental sensitivity for concerns such as wildlife habitat, sensitive soils and regeneration. Areas classified as environmentally sensitive were excluded from the timber harvesting land base according to Table A-10.

Table A-10. Area considered unavailable for timber harvesting due to environmental sensitivity

ESA category	ESA description	Total forested area (hectares)	Percent of area unavailable for timber harvesting (%)	Area removed specifically for ESA (hectares)
Ea	Snow avalanche	0	100	0
Ep1	Regeneration problems high	9 878	100	776
Ep2	Regeneration problems moderate	7	100	7
Er1	Recreation high sensitivity	104	100	12
Es1	Soil high sensitivity	135 284	100	26 828
Ew1	Wildlife high sensitivity	2 652	100	1 003
Ew2c	Significant caribou habitat	27 654	100	891
Ew2g	Significant goat habitat	0[a]	100	0
Total		175 580		29 517

(a) A total of 183 hectares are identified as caribou and goat habitat. This area is accounted for under the significant caribou habitat.

A.3 Definition of the Timber Harvesting Land Base

Environmentally sensitive area reductions were established by the Ministry of Forests (MoF) staff in collaboration with the Ministry of Environment, Lands and Parks (MELP). In addition to the wildlife habitat areas identified in the inventory files as ESAs, it is recognized that wildlife habitat will be maintained by current management practices throughout the Fort Nelson TSA. This habitat is accounted for through wildlife tree patches, riparian reserves, and biodiversity considerations.

The habitat requirements for areas of moderate wildlife significance with a modifier indicating significant habitat for caribou and goat cannot be met with simple modifications of current harvest practices, thus they are removed from the timber harvesting land base.

All of the area with moderate regeneration problems is removed due to the significant competition problems in the Fort Nelson TSA.

A.3.11 Range areas

Range burns are prescribed fires used by Ministry of Environment, Lands and Parks (MELP) staff to create grassland forest habitat complexes that provide grazing opportunities for wild ungulates and domestic horses. Most of the 337 848 hectares excluded from the timber harvesting land base due to the range burn classification are located in the western portion of the TSA. Areas on which range burns are carried out have been identified by MELP in a GIS, and are identified on the inventory data set used for the analysis (BURNS = B). Of the total area identified as range burn, 132 074 hectares are classified as productive forest land, and a total of 16 110 hectares were removed specifically for range burns.

A.3.12 Existing unclassified roads, trails, and landings

Many roads, trails and landings constructed for forest access and harvesting are not large enough to be classified on the inventory file. Based on a summary of harvested areas, Fort Nelson Forest District staff estimated that unclassified roads, trails, landings, and dispersed disturbance due to harvesting activity cover about 4.0% of the currently accessed timber harvesting land base. A 4% reduction was applied to stands 40 years or younger, based on the assumption that the majority of harvesting has occurred over the past 40 years.

Past harvest operations were carried out close to existing main line roads and have often utilized existing seismic lines. The future roads reduction, Section A.3.16, "Estimated area of future roads, trails and landings," is expected to be greater than for existing roads, as harvest operations move into areas with no current seismic activity, and the use of spur roads increases to access areas not adjacent to main line roads.

A total of 4559 hectares were removed to account for existing roads, trails and landings. Some existing access roads have built through mature timber; therefore some productive loss between blocks actually applies to stands older than 40 years. However, this area is very small in relation to the mature forest area, and the reduction applied to the area currently 40 years and younger adequately represents the current total area in roads, trials and landings.

Table A-11. Estimates for existing roads, trails and landings

Roads, trails and landings	Age (years)	Within block productive loss (%)	Productive loss between blocks (%)	Total reduction per cent (%)
Existing	≤ 40	2.5	1.5	4.0

A.3 Definition of the Timber Harvesting Land Base

A.3.13 Stand-level biodiversity reductions

The *Landscape Unit Planning Guide* recommends the use of either wildlife trees or wildlife tree patches for maintaining stand structure over time. In the Fort Nelson TSA, wildlife tree patches (WTPs) are normally used, and are generally larger than two hectares in size. As the WTPs are larger than two hectares they will contribute to meeting the old-seral stage forest requirements at the landscape level. It is assumed that the WTPs will not be economical to harvest at a later date, nor will they be available to harvest in subsequent harvesting of the stand. Therefore, they were accounted for in the analysis by excluding area from the timber harvesting land base.

Table A-12. Reductions to reflect volume retention in cutblocks for wildlife tree patches

Management zone	Analysis unit	Persistence	Per cent (%) recommended for the Fort Nelson TSA	Reduction applied to the timber harvesting land base (%)
All	All	Long term	10	5

Staff from the Fort Nelson Forest District and the Ministry of Environment, Lands and Parks, have published stand-level biodiversity guidelines for the Fort Nelson district that require a minimum retention of 10% of the total area under prescription for wildlife tree patches.

The figure of 5% shown in Table A-12. is based on the assumption that only one-half of the total requirement of 10% must be provided through within block considerations. It is assumed the remaining 5% will be accounted for from areas that do not contribute to the timber harvesting land base; for example, from areas not harvested due to riparian considerations.

A.3.14 Seismic areas

An extensive oil and gas exploration and development industry is operating throughout the Fort Nelson TSA, most predominantly on the lowland areas. The activities of this industry, mainly the establishment of seismic lines, result in a depletion of forest cover. The current forest inventory contains information on seismic line activity up to 1994. To reflect forest depletion from seismic activity, the seismic lines in the TSA were mapped using a geographic information system (GIS). The width of all seismic lines was assumed to be seven metres. The buffering exercise indicates 28 991 hectares of forest have been converted to seismic lines (SEISMIC = 100), of which 12 524 hectares were excluded from the timber harvesting land base specifically due to seismic activity. The other 16 467 hectares have already been excluded from the timber harvesting land base through previous reductions.

A.3 Definition of the Timber Harvesting Land Base

Since 1994, an estimated additional 4334 hectares of forested area have been depleted because of oil and gas exploration. Based on the assumption that the same portion of the total forested area affected by seismic operations would be excluded from the timber harvesting as for operations prior to 1994 (12 524/28 991=43%), a further exclusion of 1872 hectares was made.

Although future forest depletion due to seismic activity is likely, it is not possible to accurately estimate the extent and location of these losses. As well, it is not possible to predict the proportion of the seismic lines that will return to productive forest. Therefore, for this analysis it was assumed that the amount of seismic line disturbance remained constant throughout the modelling period.

A.3.15 Uneconomic areas

Fort Nelson Forest District staff identified areas that would be uneconomical to harvesting based on a review of the preliminary timber harvesting land base in combination with a Delivered Wood Cost assessment (DWC).

The DWC study provided a cost in dollars per cubic metre ($/m³) based on the costs of harvesting, processing, transportation, and regeneration associated with each forest stand. For mature stands, the DWC estimates were based on the volume of all wood currently above the prescribed regional priority harvesting age. For immature stands, the DWC was assigned based on volume estimates at prescribed harvesting ages. The study provides an estimate of relative costs of operating in different inventory regions and compartments rather than a precise prediction of the costs that will be incurred. Based on this assessment, geographically specific areas were identified as uneconomical for timber harvesting, due to physical inaccessibility, isolation, or other factors. After all land base exclusions discussed to this point, 114 357 hectares were identified as uneconomical for timber harvesting, and were excluded from the timber harvesting land base.

The following inventory region / compartments, which are considered as uneconomic areas, were excluded from the timber harvesting land base:

- Region 78, compartment 38;
- Region 79, compartments 27, 29, 30, 31, 32, 33, 35, 36, 37, 40, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 61, 63, 64, 65, 66, 67, 68, 69, 70, 73, 74, 85, 86, 87, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 124, 157, 160, 162, 163, 164, 166, 167, 168, 169, 171, 172, 173, 174, 175, 176;
- Region 86, compartments 3, 28, 33, 34, 35, 44, 54, 55, 56, 57, 58, 59, 63, 64, 67, 68, 70, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 95, 98, 105, 106, 107, 109, 110, 115, 116, 117, 118, 119, 120, 121, 122, 124, 125, 126, 134, 151, 155, 158, 159, 161, 162, 163, 164, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190;
- Region 87, compartments 1, 27, 28, 29, 53, 54, 69, 72, 73; and,
- Region 88, compartments 1, 12, 38, 45, 54.

A.3 Definition of the Timber Harvesting Land Base

A.3.16 Estimated area of future roads, trails and landings

To account for the loss of productive forest land to the establishment of roads, trails, and landings associated with future timber harvesting, a portion of the timber harvesting land base is not considered to contribute to further timber production after it is harvested for the first time. Based on a review of silvicultural prescriptions, Fort Nelson District staff estimated these losses to be 5.0% as shown in Table A-13. This area was deducted only from stands older than 40 years (since it is assumed that all stands younger than 40 years have already been accessed).

Table A-13. Estimates for future roads, trails and landings

Roads, trails and landings	Age (years)	Within block productive loss (%)	Productive loss between blocks (%)	Total reduction per cent (%)
Future	> 40	2.5	2.5	5.0

A.3.17 Cultural heritage resource reductions

Cultural heritage resource inventories for the Fort Nelson TSA are ongoing and are incomplete. The Ministry of Forests is currently working with local First Nations to complete these inventories and develop appropriate management strategies for the protection of identified sites. For the timber supply analysis it was assumed that protection of cultural heritage resource sites within the timber harvesting land base will be accommodated through reductions for riparian reserves and riparian management zones (A.3.9) and stand-level biodiversity (A.3.13). Future analysis is expected to incorporate management for cultural heritage resource values more explicitly, as inventories are completed and appropriate management strategies for the protection of the sites are developed.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

Utilization levels define the standards to which trees are harvested. These levels are used to calculate merchantable timber volumes.

In the Fort Nelson TSA, according to licence requirements and current performance, timber is currently utilized as outlined in Table A-14.

Table A-14. Utilization levels

	Utilization		
Leading species	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Spruce	17.5	30	10
Pine	12.5	30	10
Balsam	17.5	30	10
Cottonwood	12.5	30	10
Aspen	12.5	30	10

The utilization level for minor components of birch, and for the sensitivity analysis examining the potential contribution of leading birch stands, was a minimum dbh 12.5 cm; maximum stump height 30 cm; and minimum top dib 10 cm.

As a minor species, larch is utilized to a dbh of 12.5 cm; maximum stump height 30 cm; and minimum top dib 10 cm.

A.4 Forest Management Assumptions

A.4.2 Minimum harvestable age by analysis unit

Minimum harvestable age defines the earliest age at which a stand may be harvested, not the age at which harvesting must occur. The ages were determined by examining the volume tables for each analysis unit within each of the four resource management zones, and using linear interpolation to determine the age at which the minimum volume was estimated to be attained. Table A-15. lists the minimum harvestable ages for each analysis unit by resource management zone for both existing and regenerated stands.

Table A-15. Minimum harvestable age criteria

			Minimum criteria							
			Minimum harvestable age (years)							
			Existing stands				Regenerated stands			
	Analysis unit	Volume (m^3/hectare)	Management zone							
			1	2	3	4	1	2	3	4
1	Spruce	140	78	73	82	81	67	62	71	70
2	Spruce/pine	140	83	81	79	94	70	67	67	78
3	Spruce/deciduous	140	80	76	83	84	80	76	83	84
4	Aspen/coniferous	140	60	59	72	63	60	59	72	63
5	Aspen/coniferous	140	62	58	72	66	62	58	72	66
6	Pine	140	53	54	58	63	45	45	50	52
7	Pine/deciduous	140	60	62	64	66	60	62	64	66
8	Cottonwood/coniferous	140	64	49	74	59	64	49	74	59
9	Cottonwood/deciduous	140	69	53	72	67	69	53	72	67
10	Spruce/larch	140	78	99	N/A	N/A	78	99	N/A	N/A
11	Balsam fir	140	99	108	114	107	99	108	114	107
12	Birch[a]	140	72	67	70	85	72	67	70	85

(a) Birch ages were used for the sensitivity analysis in which birch-leading stands were included in the timber harvesting land base.

A.4.3 Harvest profile

In the timber supply model, the highest harvest priority was given to stands that were the furthest above their respective minimum harvestable age. Other harvest profiles may be specified in the model if any apply in the area (for example, there may be a desire for a specified proportion of the total harvest to come from a particular tree species). No specific profile was used in the Fort Nelson TSA analysis, except to track the coniferous and deciduous timber supply separately.

A.4.4 Forest cover requirements

This analysis did not involve explicit tracking of the spatial relationships among cutblocks and other land units. However, for the analysis, the TSA was separated into landscape units, biogeoclimatic units, and leading species types, as well as by management emphasis, so the data files incorporated spatially specific information. The timber supply model (FSSIM Version 2.2) allows the application of forest cover requirements that specify either the maximum proportion of an area allowed in a disturbed condition, or the minimum required area of old-age forest. The forest cover requirements applied in this analysis approximate current forest management practices.

To approximate cutblock adjacency objectives, forest cover requirements permitting a maximum of 39% of the timber harvesting land base within any landscape unit to be shorter than three metres were applied.

Visual management concerns were also modelled. The *Procedures for Factoring Visual Resources into Timber Supply Analyses* were used to derive forest cover requirements for the VQO zones. A visually effective green-up height of five metres was used for all VQO areas, as per local estimates and the above *Procedures* document.

A.4 Forest Management Assumptions

Table A-16. Forest cover requirements for visually sensitive areas

VQO class	Green-up height (metres)	Green-up maximum allowable disturbance (% area)
Retention VQO	5	3
Partial retention VQO	5	10
Modification VQO	5	20.5
Maximum modification VQO	5	33

The forest cover requirements in Table A-16. were applied to each VQO class within each landscape unit. Forested area excluded from the timber harvesting land base was assumed to contribute to meeting visual objectives within each visually sensitive area.

B.C. Ministry of Forests' growth-yield models, VDYP (Version 6.4) and TIPSY (Version 2.1d) were used to estimate when trees will reach a top height of three metres (cutblock adjacency) or five metres (VQO zones). Since each area will support a range of growth rates, average green-up ages were used for each landscape unit or visual class within a landscape unit to simplify the analysis.

A.4.5 Landscape level biodiversity

Table A-17. lists the forest cover requirements for each natural disturbance type (NDT) and biodiversity emphasis option from the Forest Practice Code *Biodiversity Guidebook.*

Table A-17. Landscape-level biodiversity: biodiversity guidebook distribution objectives for each seral stage, by emphasis option, for the NDTs in the Fort Nelson TSA

NDT	Biogeo–classification	Distribution objectives (%) for each seral stage, by emphasis option								
		Early			Mature + old			Old		
		L	I	H	L	I	H	L	I	H
2	SWB	None	< 36	< 27	> 14	> 28	> 42	> 9	> 9	> 13
3	BWBS-Decid.	N/A	< 36	< 27	> 13	> 23	> 34	> 13	> 13	> 19
3	BWBS-Conif.	N/A	< 54	< 40	> 11	> 23	> 34	> 11	> 11	> 16

A.4 Forest Management Assumptions

Table A-18. shows the ages for early, mature and old seral stages.

Table A-18. Seral stage definitions by biogeoclimatic zones

NDT	Biogeo–classification	Seral stage (years)		
		Early	Mature + old	Old
2	SWB	< 40	> 120	> 250
3	BWBS-Decid.	< 20	> 80	> 100
3	BWBS-Conif.	< 40	> 100	> 140

As per the *Forest Practices Code (FPC) Timber Supply Analysis* (1996), and the FPC *Landscape Unit Planning Guide*, the base case for the Fort Nelson TSA incorporates only the old-seral objective in natural disturbance type (NDT) 2, while the mature plus old- and the old-seral objectives were applied in NDT 3. Also, early-seral objectives were not applied in the base case, reflecting the FPC analysis and current policy. Cutblock adjacency requirements were modelled in the base case, and assist in controlling the area in early seral condition.

Since biodiversity emphasis options have not been formally established, a weighted forest cover requirement was calculated based on the assumption that biodiversity emphasis objectives would eventually be established so that 45% of the area is subject to low emphasis, 45% to intermediate emphasis, and 10% to high emphasis options. Table A-19. outlines the resulting forest cover requirements applied in the analysis to account for landscape-level biodiversity. In the analysis, the requirements were applied to each biogeoclimatic zone within each draft landscape unit, which reflects current management in the Fort Nelson TSA.

Table A-19. Application of seral stage objectives in the analysis

Zone/group	NDT	Biogeo–classification	Minimum age mature and old (years)	Minimum retention area per cent (%)	Minimum age old (years)	Minimum retention area per cent (%)
All draft landscape units	2	SWB	N/A	N/A	250	9.4
	3	BWBS-Decid.	80	19.6	100	13.6
	3	BWBS-Conif.	100	18.7	140	11.5

A.4.6 Unsalvaged losses

This section outlines the methods used to estimate the average annual unsalvaged volume losses due to insect epidemics, fires, and wind. The purpose of the unsalvaged losses estimate is to account for catastrophic events and other factors not recognized in yield estimates. Non-catastrophic timber volume losses to insects and diseases that normally occupy stands (so-called endemic losses) are accounted for in inventory sampling for timber yield estimation. Annual unsalvaged losses of 58 000 cubic metres in coniferous-leading stands, and 6000 cubic metres in deciduous-leading stands were applied in the timber supply analysis. Table A-20. summarizes the estimate for unsalvaged losses in the Fort Nelson TSA used in the analysis.

Table A-20. Unsalvaged losses

Cause of loss	Annual losses on total land base (m^3/year)	Annual losses on timber harvesting land base (m^3/year)	Annual salvage of losses (m^3/year)	Annual unsalvaged losses (m^3/year)
Insects:				
Spruce beetle	2 026	567	0	567
Spruce budworm	31 543	8 822	0	8 822
Fire	451 000	112 550	58 173	54 377
Total	484 569			63 766

There are losses due to blowdown within some older stands in the Fort Nelson TSA. However, no estimate of these losses was available for incorporating into the analysis. Blowdown losses are sometimes associated with other forest health issues, so there is also uncertainty about the amount of overlap between loss factors. Attempts will be to gather blowdown information for inclusion in the next timber supply review for the Fort Nelson TSA.

The following adjustments were made to the annual losses:

- for spruce beetle and spruce budworm — the ratio of the area of spruce-leading stands within the timber harvesting land base relative to the total land base; and,
- for fire — the ratio of the timber harvesting land base relative to the total land base, assuming 95% of volume lost is coniferous.

Spruce budworm

Area of defoliation is from the *Defoliator and Beetle Conditions in the Fort Nelson Forest District for 1996, Forest Health Note #2, October 1996.* The average volume of stands susceptible to attack (180 cubic metres per hectare), and the attack cycle time (13 years) are professional judgments based on local information. The per cent mortality, 16% in moderately defoliated and 32% in severely defoliated stands, is based from *Spruce Budworm in the Footner Lake Forest, 1987.*

The annual losses on the timber harvesting land base were calculated by adjusting the total losses as follows:

$$\text{Total annual losses} * \frac{\text{(spruce leading area on timber harvesting land base)}}{\text{(spruce leading area on full land base)}}$$

Using this methodology, total losses from spruce budworm are estimated to be 31 543 cubic metres per year:

- 22 491 cubic metres total loss from moderate defoliation
  (10 152 ha * 180 m^3/ha / 13 years* 0.16 = 22 491 m^3/year);
- 9052 cubic metres total loss from severe defoliation
  (2043 ha * 180 m^3/ha / 13 years * 0.32 =9052 m^3/year).

Finally, unsalvaged losses from spruce budworm on the timber harvesting land base =

- 8 822 cubic metres per year
  31 543 cubic metres per year * (450 939 ha / 1 612 256 ha)

Spruce beetle

Losses from spruce beetle are estimated at 95 205 cubic metres over a complete attack cycle from 1947 to 1994 (95 205 cubic metres / 47 years = 2026 cubic metres/year). Volume loss has been estimated using information from the draft report, *Forest Susceptibility to Spruce Budworm Defoliation in the Forest Nelson Area of British Columbia*, J.S. Clowater.

- Unsalvaged losses on the timber harvesting land base from spruce beetle =
  2 026 cubic metres per year * (450 939 ha / 1 612 256 ha) = 567 cubic metres per year.

Fire

Losses from fire are based on volume lost, reported in the *Ministry of Forests General Fire Summary on the Protection Information System for January 1984 to December 1995.*

Unsalvaged losses to fire on the timber harvesting land base were calculated as:

$$\text{Total annual losses} * \frac{\text{(timber harvesting land base)}}{\text{(total forested land base)}}$$

- Annual losses on timber harvesting land base from fire =
  451 000 cubic metres per year * (924 849 ha / 3 705 975 ha) = 112 550 cubic metres per year.

Ninety-five per cent of this value is assumed to come from coniferous stands and 5% from deciduous stands.

A total of 698 077 cubic metres were salvaged following large fires in 1985 and 1996. Salvage operations only occurred following these two large fires and have not occurred annually within the Fort Nelson TSA. Annual volume salvaged is estimated by dividing the total volume salvaged by 12 years, the time period over which the current salvage philosophy is relevant. The estimated average annual fire salvage is 58173 cubic metres.

A.4.7 Regeneration activities

The growth of regenerated spruce, spruce/pine and pine stands was projected using managed stand yield tables (MSYTs) produced by the B.C. Forest Service table interpolation program for stand yields (TIPSY Version 2.1d) growth and yield model. Table A-21. indicates the inputs used to produce MSYTs for this analysis, and the analysis units to which TIPSY managed stand yield tables were applied.

Current information for regenerated deciduous, spruce/deciduous, pine/deciduous, balsam fir, and spruce/larch stands suggests that growth similar to currently existing, naturally established stands can be expected. For the analysis, these stand types were therefore modelled to regenerate and grow according to the original natural stand yield tables, developed through the VDYP (Version 6.4) model, and according to input shown in Table A-22.

A.4 Forest Management Assumptions

Table A-21. Regeneration assumptions by analysis unit for managed stands

Analysis unit	Regen delay[a] (years)	OAFs[b] 1	OAFs[b] 2	Regen method Type	Regen method %	Species Code	Species %	Density[c] (stems per hectare)
1 Spruce	4	15	5	Planted	100	Spruce	100	1000
2 Spruce/pine	4	15	5	Planted	100	Spruce	100	1000
6 Pine	4	15	5	Planted	90	Pine	90	1000
				Natural	10	Pine	10	5000

(a) Regeneration delay is the time between the completion of harvesting and the germination of the new seedlings.

(b) OAFs are operational adjustment factors. OAF1 is a constant percentage reduction at all ages to represent small stocking gaps in stands; and OAF2 is a reduction that increases with age, passing through 5% at 100 years of age, and represent losses such as decay. Provincial average OAF values are assigned as no local values are available.

(c) Density is a reflection of the total stems per hectare (adjusted for dispersal) at free growing.

Table A-22. Regeneration assumptions by analysis unit for unmanaged stands

Analysis unit	Regen delay (years)	Species Code	Species Per cent (%)
3 Spruce/deciduous	4	Spruce/deciduous	100
4 Aspen/coniferous	2	Aspen/coniferous	100
5 Aspen/deciduous	2	Aspen/deciduous	100
7 Pine/deciduous	4	Pine/deciduous	100
8 Cottonwood/coniferous	2	Cottonwood/coniferous	100
9 Cottonwood/deciduous	2	Cottonwood/deciduous	100
10 Spruce/larch	4	Spruce/larch	100
11 Balsam fir	4	Balsam fir	100
12 Birch	4	Birch	100

Operational adjustment factors and stocking densities were not required for the analysis units in Table A-21. since they are implicit in the yield tables, which reflect natural stand conditions.

A.4 Forest Management Assumptions

Planting does take place in some of the stand types with coniferous components listed in Table A-22. Although planting would normally result in managed conditions (stocking control) which would justify use of MSYTs, the stands were projected using natural stand yield tables due to the significant amount of natural regeneration and ingress that also occurs.

A.4.8 Not satisfactorily restocked (NSR) areas

In the TSA inventory file, 142 238 hectares of land are classified as NSR (TYPID_PR = 4 or 9). Only 25 521 hectares contribute to the timber harvesting land base. This area includes only NSR with a history of site preparation (history code SI), stand tending (ST), logging (L) or planting (PL). All other NSR does not contribute to the timber harvesting land base as it is assumed to be non-productive area, misclassified as NSR, or the result of wildfire or range burning. Table A-23. shows the NSR distribution assumed for the analysis.

Table A-23. Not satisfactorily restocked (NSR) areas

	Analysis unit	NSR to be restocked 1 to 9 years from now (hectares)
1	Spruce	6 592
2	Spruce/pine	0
3	Spruce/deciduous	4 734
4	Aspen/coniferous	2 842
5	Aspen/deciduous	0
6	Pine	7 570
7	Pine/deciduous	0
8	Cottonwood/coniferous	2 839
9	Cottonwood/deciduous	944
10	Spruce/larch	0
11	Balsam fir	0
	Total	25 521

A.4 Forest Management Assumptions

The Ministry of Forests, Integrated Silviculture Information System (ISIS) was used as a cross-check on the NSR figures in the inventory file. The NSR information on ISIS is updated regularly by forest district staff, and is not subject to the time lags between updates as is the inventory file. Therefore, ISIS is considered to be a more reliable reflection of current NSR conditions. ISIS indicates 25 654 hectares of NSR within the Fort Nelson TSA. However, 2500 hectares are classified as areas with regeneration problems, and are not included in the timber harvesting land base. This area is relatively close to the NSR area on the timber harvesting land base listed in the inventory file. Therefore, the inventory area (25 521 hectares) was used for the analysis, and ISIS was used to derive the species composition for NSR to be restocked.

In the past, areas harvested in the Fort Nelson TSA have been regenerated with lower tan optimum stocking densities. For the analysis, all young stands and NSR areas will be grown on unmanaged VDYP yield tables (Section A.5, "Volume Estimates for Existing Stands"), as these stands are not expected to produce the same volumes associated with managed stands as estimated by TIPSY (Section A.6, "Volume Estimates for Future Managed Stands").

A.4.9 Rehabilitation of problem forest types, and non-commercial cover areas

The forest cover attribute information has been updated for all areas that have already been rehabilitated. Thus rehabilitated areas are included in the timber harvesting land base. In addition, rehabilitation of 2500 hectares classified as non-commercial brush (TYPID_PR = 5) with moderate site productivity is planned over the next 10 years. These areas are primarily willow brush sites that are cleared and planted to spruce. Therefore, 250 hectares of spruce were added to the timber harvesting land base each year for the first 10 years in the analysis.

A.5 Volume Estimates for Existing Stands

This section provides information on the timber yield tables used for existing stands and regenerated stands other than spruce, spruce/pine and pine.

A.5.1 Volume exclusions for non-utilized species

Some tree species that constitute minor components of stands are not merchantable. The volumes of these unmerchantable components were not included in volume estimates. In addition, the inventory may also have minor errors, indicating the presence of species that do not naturally occur within the TSA. Although occurrence and effect on the estimated stand volumes is minimal, these species should not contribute to the estimated volume of the stand for timber supply analysis. The following table indicates the species for which the volumes were removed from the estimated stand volumes.

Table A-24. Volume exclusions for mixed species types

Inventory type group	Species	Volume exclusion (%)
38–39	Alder/maple	100
1–8	Douglas-fir	100
12–17	Hemlock	100
9–11	Cedar	100

Volumes for all other species are included in the yield projections. Stands in which the species listed in Table A-24. are leading were excluded entirely from the timber harvesting land base (see Section A.3.6, "Non-merchantable forest types").

A.5.2 Timber yield tables for existing stands and future deciduous, minor coniferous and mixedwood stands

The variable density yield projection model (VDYP), version 6.4a was used to develop timber volume projections for all existing stands, and future deciduous, mixedwood, spruce/larch and balsam fir stands. The volume tables for projecting estimated growth are listed in Table A-25., by management zone and analysis unit.

A.5 Volume Estimates for Existing Stands

Table A-25. Timber volume tables for existing stands (cubic metres)

Zone 1: Integrated resource management category

Age (years)	AU 1 Spruce	AU 2 Spruce/ pine	AU 3 Spruce/ decid	AU 4 Aspen/ conif	AU 5 Aspen/ decid	AU 6 Pine	AU 7 Pine/ decid	AU 8 Cotton- wood/ conif	AU 9 Cotton- wood/ decid	AU 10 Spruce/ larch	AU 11 Balsam fir
10	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	7	11	21	13	9	4	0	0
40	3	1	2	48	51	76	53	40	27	6	5
50	20	13	18	96	93	126	98	88	69	26	19
60	60	42	54	140	133	170	139	126	108	65	45
70	106	84	99	181	171	209	175	159	142	108	76
80	148	127	141	214	201	244	206	186	171	147	101
90	185	166	178	243	226	276	234	209	196	182	123
100	217	202	211	266	246	305	259	229	217	213	142
110	245	234	239	284	261	332	280	245	234	241	160
120	269	264	263	297	272	357	300	260	250	266	176
130	291	292	283	307	277	380	317	272	262	288	192
140	311	314	301	317	284	395	328	282	273	307	207
150	328	333	316	325	291	407	337	292	282	323	222
160	343	348	326	329	291	415	342	294	283	336	234
170	357	361	335	332	292	420	345	296	283	346	246
180	369	371	343	334	292	421	346	298	283	355	257
190	379	379	350	336	292	419	344	300	283	363	268
200	389	388	356	338	292	421	346	301	284	370	278
210	397	396	362	340	292	424	347	302	284	376	288
220	405	403	367	342	293	426	349	304	284	382	298
230	412	410	371	343	293	429	351	305	284	387	307
240	418	416	376	344	293	432	353	306	284	392	315
250	423	422	379	345	293	434	354	306	284	396	323
260	428	427	382	346	293	437	356	307	284	400	326
270	433	431	385	347	293	439	357	308	285	403	328
280	437	436	388	348	293	441	359	308	285	406	330
290	440	439	390	349	293	443	360	309	285	409	332
300	443	443	393	350	293	445	361	309	285	411	334
310	446	446	395	350	293	447	362	310	285	413	336
320	449	449	396	351	294	448	363	310	285	415	338
330	451	451	398	351	294	450	364	310	285	417	339
340	453	454	399	351	294	451	365	310	285	418	341
350	454	456	400	352	294	452	365	311	285	420	342

(continued)

A.5 Volume Estimates for Existing Stands

Table A-25. Timber volume tables for existing stands (cubic metres)

Zone 2: Integrated resource management in major river corridors

Age (years)	AU 1 Spruce	AU 2 Spruce/ pine	AU 3 Spruce/ decid	AU 4 Aspen/ conif	AU 5 Aspen/ decid	AU 6 Pine	AU 7 Pine/ decid	AU 8 Cotton- wood/ conif	AU 9 Cotton- wood/ decid	AU 10 Spruce/ larch	AU 11 Balsam fir
10	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	2	2	0	0
30	0	0	0	8	16	20	7	36	26	0	0
40	4	0	4	51	60	73	50	91	78	0	2
50	32	14	24	101	104	122	94	147	129	0	11
60	79	49	66	147	147	166	134	191	171	5	34
70	127	93	114	189	187	205	169	227	205	39	63
80	170	136	157	222	218	240	201	257	232	75	86
90	207	175	195	251	244	271	229	282	254	110	106
100	239	210	227	274	266	300	254	302	273	142	126
110	267	243	255	292	281	327	277	319	289	172	144
120	290	273	279	306	292	352	298	334	302	199	159
130	312	300	299	315	298	376	317	347	313	224	173
140	331	322	316	324	305	391	330	357	322	247	185
150	347	341	331	333	311	403	340	367	331	267	196
160	362	356	341	337	312	411	347	369	331	283	207
170	374	368	350	340	312	416	351	371	331	297	217
180	386	378	358	342	313	417	352	372	331	309	226
190	396	386	365	344	313	415	351	374	331	320	235
200	404	395	371	346	313	417	353	375	331	330	244
210	412	403	377	348	313	419	355	376	332	339	252
220	419	410	381	350	314	422	357	377	332	347	260
230	426	416	386	351	314	425	360	378	332	355	268
240	431	422	390	352	314	428	362	379	332	362	275
250	436	428	393	353	314	430	364	379	332	368	282
260	441	433	397	354	314	433	366	380	332	374	284
270	445	437	399	355	314	435	368	381	332	379	285
280	448	441	402	356	314	437	369	381	332	384	287
290	451	445	404	356	314	440	371	381	332	389	288
300	454	448	406	357	315	441	372	382	332	393	289
310	456	451	408	357	315	443	374	382	332	397	290
320	458	454	409	358	315	445	375	382	332	400	291
330	460	457	411	358	315	446	376	383	332	404	292
340	461	459	412	359	315	447	377	383	332	407	293
350	463	461	413	359	315	449	378	383	332	410	294

(continued)

A.5 Volume Estimates for Existing Stands

Table A-25. Timber volume tables for existing stands (cubic metres)

Zone 3: Special management category

Age (years)	AU 1 Spruce	AU 2 Spruce/ pine	AU 3 Spruce/ decid	AU 4 Aspen/ conif	AU 5 Aspen/ decid	AU 6 Pine	AU 7 Pine/ decid	AU 8 Cotton- wood/ conif	AU 9 Cotton- wood/ decid	AU 10 Spruce/ larch	AU 11 Balsam fir
10	0	0	0	0	0	0	0	0	0	N/A	0
20	0	0	0	0	0	0	0	0	0		0
30	0	0	0	2	1	9	8	1	2		0
40	1	3	3	31	33	59	44	10	10		1
50	13	17	14	68	69	106	87	58	51		11
60	47	52	45	103	102	148	125	97	94		29
70	91	98	88	136	134	186	160	129	132		58
80	132	143	130	163	159	219	189	158	165		81
90	168	184	167	186	181	249	216	182	194		100
100	199	221	198	206	199	277	239	203	218		118
110	227	255	225	222	213	303	260	222	239		134
120	251	286	249	235	223	326	278	237	257		148
130	273	314	269	244	229	348	294	252	272		163
140	293	338	287	253	236	363	305	264	285		178
150	310	358	302	260	241	375	314	276	296		192
160	325	374	312	263	241	383	319	279	296		205
170	339	388	321	266	242	388	322	281	296		217
180	351	400	328	267	242	389	323	284	297		229
190	362	409	335	268	242	388	322	286	297		240
200	372	419	341	269	242	390	323	288	297		250
210	381	427	346	271	242	393	325	290	297		261
220	388	435	351	272	242	396	327	291	297		270
230	396	443	355	273	242	399	328	293	297		280
240	402	450	359	274	242	401	330	294	297		289
250	408	456	363	275	243	404	332	295	297		298
260	413	461	366	276	243	406	333	296	297		300
270	418	466	369	277	243	409	335	297	297		302
280	422	471	371	278	243	411	336	298	297		304
290	425	475	373	278	243	413	337	299	297		306
300	428	479	375	279	243	414	338	300	297		308
310	431	482	377	279	243	416	340	300	297		310
320	434	485	379	280	243	417	341	301	297		311
330	436	488	380	280	243	419	341	301	297		313
340	438	490	381	281	243	420	342	302	297		314
350	439	492	382	281	243	421	343	302	297		315

(continued)

A.5 Volume Estimates for Existing Stands

Table A-25. Timber volume tables for existing stands (cubic metres) (concluded)

Zone 4: Special management in major river corridors

Age (years)	AU 1 Spruce	AU 2 Spruce/ pine	AU 3 Spruce/ decid	AU 4 Aspen/ conif	AU 5 Aspen/ decid	AU 6 Pine	AU 7 Pine/ decid	AU 8 Cotton- wood/ conif	AU 9 Cotton- wood/ decid	AU 10 Spruce/ larch	AU 11 Balsam fir
10	0	0	0	0	0	0	0	0	0	N/A	0
20	0	0	0	0	0	0	0	0	0		0
30	0	0	0	4	9	3	10	7	8		0
40	1	0	0	41	45	44	44	49	40		2
50	12	1	9	86	84	89	84	102	81		16
60	49	14	40	128	121	129	121	143	118		36
70	95	52	84	167	155	164	152	178	148		65
80	136	91	126	198	183	194	180	207	174		88
90	173	128	162	225	206	222	205	231	195		108
100	205	162	193	247	225	246	227	251	213		128
110	233	194	220	265	240	267	247	269	228		146
120	257	223	244	278	250	286	266	283	241		163
130	279	249	264	288	256	303	282	296	252		179
140	299	270	282	297	263	316	292	308	261		192
150	316	288	297	305	269	326	300	317	269		205
160	332	301	307	309	269	333	305	320	269		216
170	345	313	316	311	269	337	308	322	269		227
180	357	323	324	314	269	340	309	325	269		238
190	368	331	331	316	269	340	308	326	269		249
200	378	339	337	317	270	343	310	328	269		259
210	387	346	343	319	270	345	311	329	269		268
220	394	353	348	320	270	348	313	331	269		278
230	401	360	353	322	270	350	315	332	269		287
240	408	366	357	323	270	353	317	333	270		296
250	414	371	360	324	270	355	318	334	270		304
260	419	376	364	325	270	357	320	334	270		304
270	423	380	367	326	270	359	321	335	270		305
280	427	384	369	326	270	361	323	336	270		305
290	431	388	372	327	270	362	324	336	270		305
300	434	391	374	327	270	364	325	337	270		305
310	437	394	376	328	270	365	326	337	270		305
320	439	397	377	328	270	366	327	338	270		305
330	441	399	379	329	270	367	328	338	270		305
340	443	402	380	329	270	368	329	338	270		306
350	445	404	381	329	270	369	330	338	270		306

A.6 Volume Estimates for Future Managed Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 2.1d, 1997 was used to estimate growth and yield for future managed stands. As input into this model the area-weighted site index for each analysis unit was used, along with regeneration assumptions. As indicated in Table A-21., only pure spruce, spruce/pine and pure pine stands were projected according to managed stand yield tables for the analysis. This was primarily because of the lack of information on, and experience and history with the management of deciduous, mixedwood and balsam-fir stands in the area, but also due to ingress and other management limitations. Section A.4.7, "Regeneration activities" documents the operational adjustments factors, regeneration delays and stocking densities assumed in the yield tables.

Table A-26. displays the volume tables for managed stands. Volumes are assumed to remain constant after 300 years of age.

A.6 Volume Estimates for Future Managed Stands

Table A-26. Timber volume tables for future managed stands (cubic metres)

	Zone 1			Zone 2			Zone 3			Zone 4		
Age	Analysis unit			Analysis unit			Analysis unit			Analysis unit		
(years)	S (1)	SPI (2)	PI (6)	S (1)	SPI (2)	PI (6)	S (1)	SPI (2)	PI (6)	S (1)	SPI (2)	PI (6)
0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	4	0	0	4	0	0	2	0	0	1
30	0	0	48	0	0	47	0	0	35	0	0	30
40	1	1	115	7	1	113	1	1	93	1	0	82
50	34	23	167	54	33	166	19	31	142	22	8	131
60	93	78	228	125	92	225	71	89	189	76	43	172
70	161	142	271	193	159	269	134	157	236	140	93	219
80	217	198	309	253	215	306	190	212	272	196	151	256
90	272	250	338	316	270	336	241	266	301	248	199	284
100	327	304	363	364	325	361	294	322	326	301	244	309
110	368	348	383	400	366	381	339	363	346	345	290	330
120	398	382	401	427	396	398	375	394	363	380	331	346
130	422	407	416	448	421	413	400	419	378	406	364	360
140	441	428	427	466	440	424	422	438	390	426	389	373
150	458	445	436	482	457	433	439	455	400	443	409	383
160	471	459	443	494	470	441	454	468	409	458	425	392
170	484	471	450	503	483	447	466	481	417	470	439	400
180	492	483	456	511	491	453	477	490	422	481	451	407
190	500	490	456	514	499	454	486	497	426	489	461	412
200	506	496	456	513	505	454	492	504	430	495	470	416
210	508	502	456	512	508	454	498	508	433	501	478	418
220	507	505	456	511	506	454	503	506	436	505	483	421
230	505	503	456	509	505	454	503	505	439	503	488	423
240	504	502	456	507	504	454	501	504	443	502	492	425
250	503	500	456	504	503	454	499	502	443	500	496	427
260	501	499	456	502	501	454	498	501	443	499	494	428
270	498	498	456	500	498	454	497	498	443	498	492	431
280	495	495	456	498	495	454	495	495	443	495	490	432
290	493	492	456	497	493	454	492	492	443	492	488	432
300	493	492	456	497	493	454	492	492	443	492	488	432

Zone 1 is the integrated resource management (IRM) zone. Zone 2 is the IRM zone in major river corridors. Zone 3 is the special management zone. Zone 4 is the SMZ in major river corridors (see Table A-2).

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The report identifies potential positive or negative employment and income impacts, changes in government revenues, and community impacts at harvest levels indicated by the base case harvest forecast. This type of analysis requires several assumptions of which the reader should be aware. Some of these assumptions are outlined below:

- **Employment multipliers** — the multipliers used in the analysis of indirect and induced impacts are based on analytical assumptions and estimated using data collected at a certain time, thus they reflect industry and employment conditions at that time. Consequently, they may not accurately reflect future industry conditions. While generally good indicators when based on fairly recent information, older multipliers can be dated and potentially unreflective of the industry under examination. In any impact analysis, the information should be considered as order of magnitude indicators.
- **Employment coefficients** — employment impacts associated with future harvest levels are calculated using employment coefficients (person-years per 1000 cubic metres). This approach assumes that the industry structure will be the same in future as it is today. While reasonably accurate in the short term, the employment coefficients may change in future, as a result of changing market conditions or production technologies, for example.
- **Timing of impacts** — employment impacts are shown to occur simultaneously with a change in the harvest level. While fairly accurate for the harvesting sub-sector, this may not be the case for the processing and silviculture sub-sectors of the forest industry. Additionally, indirect and induced impacts will likely occur over a longer period of time, as business and consumer spending levels adjust.
- **Processing thresholds** — processing job impacts are unlikely to occur in direct proportion to harvest changes, i.e., a 10% harvest reduction (increase) may not lead to a 10% processing employment reduction (increase). Impacts are more likely to occur in a step-wise manner related to processing thresholds. A processing threshold is the level of a mill's timber supply where, when reached, will cause a mill to either lay-off a shift (add a shift) or shut down the mill, temporarily or permanently. Accurately predicting a mill's threshold level is not possible. As a result, the analysis may overestimate processing impacts if mills continue to operate the same number of shifts, but perhaps at lower production levels, or alternatively could underestimate impacts if a mill were to eliminate a shift. Over the medium- to long-term the impact figures should be reasonably accurate, however.
- **Government expenditures** — provincial government expenditures are more related to population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite harvest changes and any subsequent change in government revenues. However, public expenditures would likely change if community population levels change sufficiently. This would amplify the community impacts of forestry job losses or gains.
- **Proportional harvest reductions** — harvest reductions are assumed to be spread evenly among all licensees and all forms of tenure.

B.2 Economic Impact Analysis Methodology

Data sources

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the Fort Nelson TSA. Other general economic data are from B.C. STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities.

Person-year of employment

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1) harvesting;
2) silviculture; and,
3) timber processing.

The procedure for estimating employment and income impacts involves several steps. The first step was to assess current activity in each of the three sub-sectors. This was followed by an estimate of indirect and induced employment and employment income impacts, using data from the Ministry of Finance and Corporate Relations and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using the Ministry of Forests stumpage estimates and other data sources.

Employment — harvesting

Direct employment in harvesting consists of all woodlands related jobs including harvesting, log transport and hauling, log salvage, planning and administration functions. While road building and maintenance work are important activities in the forest industry, the employment multipliers used in this analysis define these activities as indirect rather than direct, as a result road building and maintenance employment are not included in the direct impact estimates; including these as direct would result in double-counting and an overestimation of employment impacts.

Data on employment, place of residence and timber flows were obtained through a survey of licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of resident versus non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting — consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and,
2) Provincial direct employment in harvesting — consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting related activities.

B.2 Economic Impact Analysis Methodology

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients on a per 1000 cubic metres basis. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment — silviculture

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilizing, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part-time during the year. Because of this, silviculture jobs were converted into equivalent full-time person-years of employment. Respondents were also asked to provide estimates of the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment — timber processing

Information about employment, production and sources of timber was gathered from TSA mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber requirement was supplied by the harvest from the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest.

Employment figures were also adjusted to reflect the residences of workers; i.e., those who lived within the TSA and those who lived outside the TSA. Employment in timber processing which is supported by chip by-products from milling operations was also estimated in a similar fashion.

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates

Indirect employment in the forestry sector are those who work to provide goods and services to firms directly engaged in the basic forestry sector; for example, those who provide log transport services. Induced employment are those who work to provide the goods and services purchased by employees who are directly and indirectly engaged in the industry; for example, those who work in retail outlets. Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were used for this report: migration multipliers and no-migration multipliers. The migration multipliers assume that a displaced worker will leave the region, reducing total income in the region by his/her full wage. The no-migration multipliers assume that a displaced worker remains in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

The TSA and provincial employment multipliers used in the Fort Nelson TSA analysis are shown in Table B-1.

Table B-1. Total employment multipliers

Forest sub-sector	TSA migration multiplier	TSA no-migration multiplier	Provincial coastal migration multiplier	Provincial coastal no-migration multiplier
Harvesting	1.54	1.35	2.14	1.80
Lumber processing	1.42	1.25	2.29	1.93
Pulp and paper	N/A	N/A	3.02	2.48
Veneer/plywood	1.42	1.25	1.93	1.64

Employment estimates of alternative timber supply levels

To estimate employment generated by alternative timber supplies, the forecasted harvest level is multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions far into the future. Therefore, the employment estimates should be viewed as indicators of orders of magnitude of change rather than as precise estimates of changes in employment levels.

Employment income estimates

Employment income was calculated using average income estimates for workers in the forest industry. Income data is from Statistics Canada Survey of Employment Payrolls and Hours. In 1998, the average pre-tax annual income (less benefits) for sub-sectors of the forestry sector were approximately: $46,575 for logging and forestry services; $44,200 for solid wood manufacturing; and $53,000 for the pulp and paper sector. The weighted average annual income for direct forestry workers was $46,030. Indirect and induced employees averaged an annual income of $34,075. This figure is based on a selection of business and personal service sectors, accommodation, food and beverage sector, and the construction sector average annual wages. Income taxes were calculated based on marginal tax rates of 23% to 28% with one-third of the total income tax accruing to the province.

Provincial government revenues

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using provincial industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated. See Table B-2. Stumpage rates are higher for coniferous timber that for deciduous timber, consequently stumpage payments for the additional coniferous volumes projected in the base case harvest forecast were calculated using an average stumpage rate of $21.50 per cubic metre, which is a 1997-98 average rate for the Fort Nelson coniferous harvest.

Table B-2. Fort Nelson TSA average provincial government revenue estimates, 1996-1998

	Average revenue 1996-1998 ($1998 millions)	Revenue ($ per '000s m^3)
Stumpage, rents and royalties	15.7	11,350
Industry taxes	12.5	9,050
Provincial income tax	8.0	5,800
Total government revenues	36.2	26,200

Source: Ministry of Forests. Price Waterhouse.